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PROF. FORBES'S FOLLY.

The friends and many admirers of Prof. Forbes cannot but regret the remarkable lack of judgment recently exhibited in his hot-headed contributions to the unfortunate Niagara controversy. While he may consider—and in some degree, perhaps, with reason—that he has been subjected to injustice, both in denial of credit due for his share in the success of the Niagara project and in attacks made on his professional and even personal character, yet the course he has adopted will bring him little sympathy. His letters to English journals and his article in *Blackwood's Magazine* so manifestly betray an excited and irritable state of mind, that they might be passed by in charitable silence were it not for the many uncalled-for disparagements contained, not only of individuals, but of Americans in general. Surely Prof. Forbes can have no reason to reflect on his American employers, who, on the Rowland trial and since, have spoken heartily in his favor, but his condescending references to "my millionaires" and the lordly tone otherwise adopted in this connection would seem to indicate that no quarter is to be given to any concerned with the project that to him has apparently entailed so much bitterness. If Prof. Forbes had more carefully noted the spirit in which disinterested American engineers and others have followed the Niagara controversy, he would, we believe, have found no reason for considering that it exhibited any prejudice toward him, but rather the contrary. There is, therefore, no excuse whatever for the gratuitous sneers at things American in which Prof. Forbes indulges, and which betray a greater lack of consideration on his part than that which he so bitterly resents in others.

METHODS OF OPERATING ELECTRIC RAILWAY MOTORS.

The remarks, printed elsewhere in this issue, of Mr. C. P. Steinmetz in the discussion of Dr. Duncan's inaugural address, form a most valuable and timely contribution to the subject of electric traction. Although Dr. Bell early pointed out that no particular problem is presented in the application of the alternating-current motor to electric railway work, yet an opinion to the contrary has seemed to prevail. Mr. Steinmetz, in his remarks, disposes very thoroughly of the objection so frequently raised against the induction motor for electric railway work, of not giving sufficient starting torque, showing that in this respect it may far exceed the continuous-current motor. Another advantage of the alternating motor brought out is that as the production of heat in it is distributed over the whole apparatus, a much greater load can be taken care of for a limited time than is possible with the continuous-current motor. In discussing the applicability of the induction motor to different classes of electric traction, Mr. Steinmetz finds that the continuous-current motor has perhaps superior advantages for use on surface urban roads and on elevated roads. The reasons given for this are that usually there is practically no demand for voltages in these cases higher than what may be efficiently obtained with the continuous current; that the double trolley necessary with the alternating current is objectionable; and that the alternating-current motor, while it can operate at its normal speed with very high efficiency, does not give economical flexibility of speed, since when accelerating it has to run on the rheostats, thus introducing a factor of inefficiency not present in continuous-current running. The double trolley objection is one that may in many cases be overbalanced by the advantages of the alternating-current motor through its lack of a commutator and security from "burn-outs," and it is not unreasonable to suppose that the future will probably develop some means of overcoming

the objection in regard to inefficiency in accelerating. As it is, however, the field for which the induction motor is now pronounced incontestably superior is one containing immense possibilities, and the practical experience which promises soon to be gained therein, its use will definitely settle whether or not the continuous-current motor will eventually be entirely displaced for traction purposes.

STEAM vs. ELECTRIC RAILWAYS.

In this issue we print the remarks made by Dr. Duncan at the conclusion of the discussion of his Niagara inaugural address on "The Substitution of Electricity for Steam in Railway Practice," in which he reiterates the opinion that at the present time the conditions are not favorable for any extensive adoption of electric traction on the trunk lines of existing steam railways. In the Niagara address, it will be remembered, the conclusions expressed by Dr. Duncan were that, while the tendency of passenger transportation on the steam lines had been in the direction of the greatest electrical economy, the tendency of freight transportation has been in the direction of least electrical economy; consequently, that while it will not pay any two-track through line with considerable traffic to equip its main tracks electrically, it will pay a four-track road to thus equip all tracks, unless a considerable portion of the business is through passenger traffic; also, it will pay all larger roads either to equip a number of their branch lines electrically or to control competing lines, while, in order to remain on a dividend-paying basis, it is imperative that most of the two-track lines either build additional tracks or control the electric roads that parallel them. In his final remarks, Dr. Duncan adds that at the present moment not more than three or four steam trunk roads in the United States would be prepared to take advantage of any electrical system of traction that might be offered to them, for the reasons given above. While the exceptions made are, in themselves, notable and offer encouragement, yet, at the present day, the discussion of the subject of the substitution of electricity for steam on trunk lines is one that offers little profit, since the unquestioned field for electric traction is yet large enough to absorb the energies of the industry for some time to come. The extension of electric traction to trunk roads will probably be by a process of evolution, following its introduction on branch lines, and on sections of the main line where the local passenger traffic is heavy. Though enthusiasts may feel disappointed that they cannot witness the immediate accomplishment of their wishes, those most interested in the electric railway industry are not likely to lose sight of the fact that failures resulting from a premature attempt at its extension, would have a depressing effect on the entire industry.

THE B. A. MAGNETIC UNITS.

Elsewhere we note the recent action of the British Association with respect to magnetic units, and in another column print an analysis pointing out some grave objections to its proposals. The question of magnetic units may be said to present three issues - one relating to the need of specific names, another to the magnitude of practical units, and a third to the selection of names. In regard to the first, our English contemporary, the *Electrician*, which had always expressed itself in opposition to specific names for magnetic units, in summing up a recent and extensive correspondence on the subject in its columns, frankly admitted a strong drift of opinion favoring such names. It is gratifying that the soundness of the American view has thus been confirmed, and still more so that the British Association has added its formal approval. As to the action of the British body on the second issue, we believe a grave mistake has been made in creating a new unit. In their reports on the International Congress proposals of the American Institute of Electrical Engineers, the national electrical associations of both France and Germany officially arrayed themselves strongly against the making of new magnetic units and in favor of the C. G. S. system for practical use, and the national American body has definitely committed itself to the same position. The British Association, therefore, can scarcely hope in view of this to ever see its unit of magnetic flux enter into international use, and consequently its creation is little less than a misfortune to the British electrical profession, and a menace to international scientific unity. As to the names adopted, did we not have the highest respect for the British Association we might have difficulty in escaping from the thought that its action lacked international courtesy. The American system of units was thoroughly discussed before its committee, and it must have been known that it had already entered extensively in use in this country; in the light of this it was certainly inconsiderate to appropriate the names here adopted and apply them in an entirely different manner in another system. In one case the name of the C. G. S. unit of magnetic flux is applied to a new unit of the same quantity, and in another the name of the C. G. S. unit of magnetic intensity to the C. G. S. unit of M. M. F. As the B. A. system, like the American system, is merely proposed as a provisional one subject to international approval, it would have been infinitely better to have either adopted the gilbert in one case, or, as should have been done in the case of the unit of flux, used another name. To sum up, as the matter now stands, there are two sets of practical magnetic units before the world on trial previous to final international action on the subject of such units, which action will probably not be taken before 1900. Of the two sets, the American forms a complete system, and is already in extensive use; it was originated by the British Association itself 20 years ago, and therefore can boast in this respect the sanction of that body; as a practical system it meets the approval of the French and Germans, and there is every reason to believe that they, five years hence, when the names shall have become firmly fixed in this country, will not seriously object to their definite adoption for international use. On the other hand, the B. A. units are inconsistent; they form an incomplete system and one which cannot practically be completed; by including a new unit, determined continental opposition is actually invited; and, perhaps most important of all, the student, whose needs are most concerned, has another burden added instead of being relieved. We are inclined to believe that if the British Association, instead of attempting to settle a question of extreme importance in a few hours, had put it over to another meeting, quite a different result would have been attained. As it is, there seems to be no hope of its proposals finding acceptance outside of Great Britain, and it remains to be seen if they even secure support there. Should they, however, finally secure favorable action from an international electrical congress, Americans can only say, "Very well, gentlemen, if you all decide to adopt new 'practical' units which we don't think we want, as we work very comfortably without them, we will, nevertheless, adopt them in the interest of international unity; we only filled in the dreary waste that existed by giving temporary names to C.G.S. units."

To Enjoin the Burial of Feeder Cables.

A suit to enjoin an electric railway company from laying wires underground is a novel proceeding. The Dublin Southeastern Tramway Company, however, was recently compelled to defend an action of this kind. Ordinarily, proceedings are begun not to prevent the burial of wires, but to enforce it. The Dublin company proposed to lay feeder cables in a trench along the road it is constructing. The injunction was prayed for on the ground that the line at present occupied the greater portion of the street, and as the trench would occupy a great portion of the side of the road, it would be in many ways a great public inconvenience and danger, and render it difficult to run gas pipes, water pipes and drains to the adjoining houses. J. Clifton Robinson, the engineer of the company, presented an affidavit demonstrating that feeder cables were absolutely essential to the operation of the road. He showed that if the defendants were allowed they could open the line by Oct. 1; if not, 200 men would be thrown out of employment. The company had spent £130,000 on the work already, he stated. The court refused the application.

The Magnetic Units Suggested by the British Association for the Advancement of Science.

It is to be sincerely regretted that the British Association, which in the past has done such excellent work for the advancement of electrical engineering, has just promulgated two proposals for practical magnetic units which are inconsistent, burdensome and equivocal.

It has, as noted elsewhere, recommended the adoption of a unit of magnetic flux equal to 10^8 C. G. S. units, to be named the weber, and has recommended the adoption of a unit of magnetomotive force equal to the C. G. S. unit, to be named the gauss.

It is a matter for congratulation that the B. A. has recognized the existing necessity among electrical engineers of adopting specific names for magnetic units. It is to be regretted that they cannot be congratulated upon their selection of such names.

It is very doubtful if these practical units and names will meet with general adoption, on account of the grave objections which may be urged against them.

The most important objections are perhaps the following :

(1) The units are inconsistent.

The suggested unit of flux belongs to the practical system of the ohm, volt, ampère, coulomb joule and watt, while the suggested unit of M. M. F. belongs to the C. G. S. system. The practical system is virtually based on the earth-quadrant, the 10^{-11} gramme, and the second, while the C. G. S. system is based on the centimetre, gramme and second. Consequently, none of the equations relating to the magnetic circuit, such as $\Phi = \frac{\mathcal{F}}{\mathcal{R}}$, can be carried out with these two units, unless factors are introduced which are difficult to remember.

(2) The units are incomplete.

If units for the four quantities flux, M. M. F., intensity and reluctance had all received either "practical" or C. G. S. values, and had been so christened by the B. A., at least a complete and comprehensive system would have been created. As it is, with the two hybrid units offered, it is necessary for the student to first make himself acquainted with the C. G. S. system in learning the fundamental relations of the magnetic circuit, and then to learn the new "practical" unit value of magnetic flux. The labors of the student, instead of being lightened, are thus needlessly increased by the proposed change.

Again, if in the future it should be desired to complete the magnetic system by the addition of a practical unit of reluctance, this unit will have a value of one hundred millionth of the C. G. S. unit, and the reluctances of usual dynamo circuits will be of the order of hundred of billionths (10^{-11}).

(3) The names proposed for the units are equivocal.

If the committee of the British Association could not see fit to accept the units provisionally adopted by the American Institute of Electrical Engineers, it would at least have been conducive to the interest of electrical engineering to suggest names that were not already extensively used with entirely different meanings.

The serious objection is that they have selected the name weber for a unit of magnetic flux one hundred million times greater than the American unit of the same name. They have also selected the American unit of M. M. F., here called the gilbert, and have proposed to name it the gauss, which is the name for the American Institute unit of flux density.

Assuming that the B. A. will use these new names, the perplexity of a student in finding two webers of different values and two gausses with entirely different meanings can best be imagined.

If the new B. A. system of magnetic units possessed even the merit of consistency and completeness, there might be some hope of its adoption in America, if only for the true interests of engineering progress, but the American Institute system, being a consistent and complete system, namely, the C. G. S. system, which has been in international use for the last 20 years, and originally created by the B. A., it cannot be expected that it should be replaced by the incomplete hybrid system proposed.

Electricity on the Erie Canal.

A preliminary test of the Lamb system of electric canal-boat haulage on the Erie Canal will be made Oct. 5, and an official test on Oct. 12. Vice-President Frank W. Hawley, of the Cataract General Electric Company, has personal charge of the experiments.

The Buffalo-Niagara Franchise.

The joint committee of the Buffalo Council has amended the terms of the franchise offered to the Niagara Falls Power Company with a view to meeting all possible objections on the part of the latter.

The clause requiring the company accepting the franchise to provide accommodations on its poles and in its conduits for two competing companies was amended so as to apply to only one company, which must avail itself of the privilege within ten years and pay a proportionate share of the construction and maintenance of the facilities thus accorded.

The clause giving the Board of Public Works power to order wires under ground at any time was amended so as to allow six months in which to begin work and one year in which to complete it.

The clause imposing a tax of 5 per cent. on gross receipts was changed so as not to become operative until five years after the supply of current to consumers has commenced.

As to the life of the franchise, which in the original franchise offered was limited to 25 years, the new clause grants a life of 36 years, with a provision for a readjustment of its terms as regards compensation to the city at the end of 18 years. The Niagara Company desired a life of 36 years without any conditions.

The American Institute of Electrical Engineers.

The September meeting of the American Institute of Electrical Engineers was held on Wednesday evening, Sept. 25, at the Hoffman House. A paper by Mr. Charles S. Bradley, on "Phasing Transformers," which is given in full elsewhere in this issue, was read by the author, and the apparatus described in the paper was shown in operation.

After an interesting discussion, participated in by President Duncan, Drs. Emery and Hutchinson, and Messrs. Kennelly, Perry and Sachs, Mr. Bradley gave the members present something of a surprise party in the shape of an elaborate collation, to which everybody did full justice.

At a meeting of the Council in the afternoon Prof. F. A. C. Perrine, of Leland Stanford University, Palo Alto, Cal., was appointed local secretary for San Francisco and vicinity. In order to provide a more cenral location for the meetings of Western members at Chicago the report of the committee appointed at the Niagara Falls meeting to consider this question was taken up, and the use of the rooms of the Western Society of Engineers in the Monadnock Building was authorized for the present season as recommended by the committee. Through the courtesy of the Armour Institute meetings requiring the use of apparatus will be held there as heretofore.

The New B. A. Magnetic Unit and Suggested Nomenclature.

Following are the several suggestions endorsed by the British Association toward establishing a new magnetic unit, giving a name to the C. G. S. unit of M. M. F. (F.), and adopting certain terminations for scientific names :

(1) That as a unit of magnetic field, 10^8 C. G. S. lines be called a *weber*. (A *weber* added per second at a steady rate to the field girdled by a wire circuit induces one volt in every turn of that circuit.)

(2) That the C. G. S. unit of magnetic potential or magnetomotive force be called a *gauss*. (An ampere-turn corresponds to $\frac{4\pi}{10}$ (or 1.2566) *gauss*. Hence the number of *gauss* round any closed curve linked on an electric circuit is equal to $\frac{4\pi}{10}$ times the number of ampere-turns in the circuit.)

(3) That the termination *-ance* be used in general for words expressing the properties of a definite body or piece of matter ; *e. g.*, resistance, conductance, inductance, permeance, etc. And that the termination *-ivity* or *-ility* or the like be used for words expressing the specific properties of a material ; *e. g.*, conductivity, resistivity, inductivity, refractivity, permeability, etc.

Commenting on the above action the London *Electrician* says that after long wallowing in the mire of empiricism as the result of a mistaken step at the outset of its career, the science of magnetic measurement has made one more effort to get its feet on to firm ground. Of the success which may attend this latest struggle toward an emancipation from empiricism it believes it is not yet time to speak, and points out that the results of the work of the committee are offered merely as suggestions and not as dictatorial laws. The humility with which they were brought forward it believes will enhance their claim to international consideration.

The most striking criticism of these proposals, the *Electrician* says, was made by Prof. Silvanus Thompson, who pointed out that the term *weber* had already been adopted in America for the C. G. S. unit of flux—viz., one *line*. And, though he agreed with the proposal to name the C. G. S. unit of magnetic potential the *gauss*, he mentioned that the term *gilbert* had been proposed by the American Institute of Electrical Engineers for that which it is here proposed to call the *gauss*; while *gauss* itself suggests in American language the unit of magnetic flux density. Whether such clashing between the usages in the two countries is or is not liable to lead to confusion, the *Electrician* considers its readers will not need any assistance to enable them to judge. Another important fact pointed out is that no dynamo yet built has a total magnetic flux so large as one *weber*; the consequence being that only fractions—often very small fractions—of one *weber* would be spoken of in practice. In concluding his remarks, Prof. Thompson called attention to that system of magnetic units which alone, of all systems, deserves to be called rational—namely, that proposed by Mr. Oliver Heaviside. The opinions of the speakers in the discussion were divided in regard to the practicability of adopting this system now; many feared that it was too late for so radical a change; others thought the change could be made in 30 or 40 years; while some were disposed to regard the revolution as being within the range of present possibilities, and as far less difficult a task than the revolution of a system of weights and measures, or the shifting of the standard meridian of commercial and scientific time in any country.

The American Street Railway Association.

The 14th regular (annual) meeting of the American Street Railway Association will be held in the Windsor Hall, Montreal, Canada, on Tuesday, Oct. 15, commencing at 10 o'clock a. m., and continuing four days. Among other interesting features will be reports of special committees on the following subjects: "Transfers," "Municipal Ordinances," "Labor Question; Wages Paid to Employees," "Experience of Roads in Furnishing Free Music and Other Entertainments to the Public," and "Physical Operation of Roads."

The executive committee has secured Victoria Rink, Montreal, Canada, for the exhibition of supplies of every nature used in the street railway business. The building has been engaged for two entire weeks, beginning Oct. 9, and ending Oct. 22, thereby giving ample time for the setting up and removal of the largest exhibits. The hall for the meeting is adjacent to the exhibition building, and delegates will therefore be enabled to examine the exhibits to the best advantage and with the least possible loss of time. The exposition department will be in charge of Mr. Stonewall Jackson, 27 St. Sacrament Street, Montreal.

The banquet will take place on Thursday evening, Oct. 17, and each company holding membership in the Association is entitled to admission for two of its officers. The charge of tickets issued to those not coming under this head will be $10 each for gentlemen and $5 for ladies.

The headquarters of the Association will be at the Windsor Hotel.

The Windsor, St. Lawrence Hall, Queens, Balmoral, and Cadillac hotels are all within a short distance of Windsor Hall and Victoria Rink. Members who expect to be present should communicate with the proprietors of the hotels as early as possible, to insure pleasant quarters.

The traffic associations have authorized the sale of tickets at reduced rates—namely, a fare and one third for the round trip. This concession applies to all attending the meeting—delegates, supply dealers and accompanying friends. The traffic associations that have extended this courtesy are the Trunk Line Association, the Canadian Pacific Company, the Central Traffic Association and the Boston Passenger Association. The usual rules applying to reduced rate tickets will be in force.

Arrangements have been made for a special train via New York Central Railway for the accommodation of delegates and others attending the Montreal Convention. The train will leave the Grand Central Station, Forty-second Street, New York, Monday, Oct. 14, at 6 p. m., arriving in Montreal Tuesday morning in time for breakfast. Passengers from Western points can connect with the special train at Utica, N. Y., Monday night, by leaving the following cities at the hours mentioned:

St. Louis, 7:55 p. m., Oct. 13; Cincinnati, 8:25 p. m., Oct. 13, via "Big Four"; Toledo, 9 a. m., Oct. 14; Cleveland, 12:50 p. m., Oct. 14, via Lake Shore; Detroit, 9:40 a. m., Oct. 14, via Michigan Central; Buffalo, 6:50 p. m., Oct. 14; Rochester, 8:43 p. m., Oct. 14; Syracuse, 10:50 p. m., Oct. 14, via New York Central.

Arrangements are being made for a daylight return trip through the beautiful Adirondack scenery, including a stop at Lake Saranac. Further information can be obtained from Mr. John N. Partridge, acting secretary, 166 Montague Street, Brooklyn.

The British Association at Ipswich.

(*From Our Own Correspondent.*)

It may be said without fear of contradiction that the recent meeting of the British Association, at Ipswich, has been, outwardly, one of the tamest on record, although it does not follow that its scientific value has been below the average. The presidential address of Sir Douglas Galton was a sober summing up of the various advances made by science since the last meeting of the British Association at Ipswich some 40 years ago. It was anticipated that Sir Douglas Galton, who has been general secretary of the Association for more than a quarter of a century, would take advantage of his election to the presidency to give a philosophic disquisition on the relation between the British Association and these scientific advances. In this respect the address was completely disappointing. The president of Section A, Prof. W. M. Hicks (professor of physics at Firth College, Sheffield), delivered a highly scientific discourse on matters connected with ether structure. The president of Section G, Prof. L. F. Vernon-Harcourt (professor of civil engineering at University College, London), had for title "The Relation of Engineering to Science"; the contents of the address, however, did not bear out the title. In Section A, Monday, Tuesday and Wednesday were mainly devoted to electrical matters, though no paper of epoch-making importance was read. The most important event in this section of the Association will be the open discussion on "Magnetic Units." This discussion has been preceded by a meeting of the electrical standards committee, at which it has been decided to follow the example of the American Institute of Electrical Engineers, and to denominate the unit of magnetic flux "weber," but to give it the value of 10^8 C.G.S. units. This is no doubt very convenient for dynamo-makers, since a conductor cutting one "weber" per second will develop a difference of potential, between its extremities of one volt, but it is very doubtful whether dynamo-designers, in this country, at any rate, are anxious to be accommodated in this particular matter, and it is much to be regretted that the electrical standards committee should add to the threatened confusion by adopting the American name for this unit, whilst giving it a different value. It is also understood that the same committee have decided to adopt the C. G.S. unit of magnetomotive force, but to give it the name of "gauss" instead of the name of "gilbert" as provisionally agreed to by the American Institute. In this case the committee, which professes to be acting solely with a view to accommodating practical men, has rejected the unit that practical men asked for, namely, "ampere-turn," and has chosen a unit which has the same value as that adopted by the American Institute, but has given it a different name. In Section G, a very interesting paper was read by P. V. Luke (deputy director of telegraphs in India) on the "Field Telegraph in the Chitral Campaign." The wire used for the line was either iron, weighing 150 pounds to the mile, or standard hard-drawn copper, weighing 80 pounds to the mile, according to local conditions. In one case a semi-permanent line was erected at the rate of nine miles per day for five consecutive days. In all, during the campaign, 327 miles of wire were put up and 26 field offices were open. The actual speed at which the line was constructed may be taken as an average of five miles per day for 37 working days. Section G was marked down this year as the happy hunting ground for gentlemen with views to air and second-hand papers to read.

Electric Equipment on the Illinois Central.

A special meeting of the stockholders of the Illinois Central Railway has been called for Nov. 26, at Chicago, to ratify the directors' decision to use electricity in its suburban service. At that meeting the stockholders will be asked to increase the capital stock of the company from $50,000,000 to $60,000,000, one half of this increase to be spent in and around Chicago, the other half to be used in the extension of the southern system. The latter portion of this statement is not official, but is said to come from excellent authority.

Bids have already been secured from builders of electrical appliances for the complete equipment of the system. It is estimated that the entire cost will be from $3,000,000 to $4,000,000. This will include the substitution of electricity for steam as the motive power in the company's car shops at Burnside.

The National Society of Electro-Therapeutists.

The third annual meeting of the National Society of Electro-Therapeutists convened in Boston on Wednesday, Sept. 18, at 10:30 a. m., with President W. L. Jackson, M.D., in the chair. The secretary, Dr. Clara E. Gary, informed the society that 25 new names had been added to the roll of members, and Treasurer J. B. Garrison, M.D., reported that the financial condition of the organization was exceedingly encouraging.

"The Development of Electro-Therapeutics and Its Relation to the Practice of Medicine" was the title of the president's address; in it he advised all physicians to investigate the subject and satisfy themselves of the value of electricity as a therapeutic agent. There are clearly defined indications for its use, he said, and it has a sphere of usefulness all its own which must be recognized.

The first paper read was that on "Some Experiments on Cataphoresis and Anaphoresis," by Prof. W. H. King, M.D., and Dr. F. M. Frazer. The authors divided electrical osmosis into cataphoresis and anaphoresis, and stated that their experiments proved conclusively that the positive and not the negative pole attracts iodine; a result in direct opposition to the previous belief. Dr. C. P. Hunt, of Wyoming, O., then read a paper on "Catalytic Effects of the Galvanic Current," in which he stated that his practice was to place the cathode upon the seat of trouble in acute and sub-acute cases, while in chronic cases, especially if complicated with paralysis, he used the anode at the seat of disease. In a paper entitled "Is the Practice of Electro-Therapeutics a Fad Practice?" Dr. E. S. Bailey, of Chicago, stated that the results attained in private practice had convinced him of the efficacy of electricity, and said it is those who do not understand it, who call it a fad.

Besides these the following papers were read, and presented data of great interest and value to the members of the society:

"Electricity in Dyspepsia," by Mr. T. G. Lajoie, M.D., of New York; "The Difficulties of Utilizing Commercial Currents for Therapeutic Purposes from an Electrician's Standpoint," by T. F. Livingstone, of New York; "Treatment of Rheumatism by Electricity," by C. G. Higbee, M.D., of St. Paul; "The General Therapeutic Effect of the Alternating Current of High Frequency and High Tension," by G. Apostoli, M.D., of Paris; "The Electrical Treatment of Locomotor Ataxia," by Prof. W. H. King, M.D., of New York; "The Selection of the Current in the Treatment of Neuritis," by N. B. Delamater, M.D., of Chicago; "Mitigating Effects of Spinal Galvanization upon the Subjective Symptoms of Tabes," by F. C. Richardson, M.D., of Boston; "Do Electric Currents Affect the Spinal Ganglia?" by E. P. Colby, M.D., of Boston; "Faradic Polarity—A Problem," by F. M. Frazer, M.D., of New York; "The Disintegration of Organic Tissues by High Tension Currents," by J. G. Parsons, M.D., of London; "Polyphased Currents and Their Effects," by Prof. W. L. Puffer, of Boston; "Polyphased Currents," by Profs. E. J. Houston and A. E. Kennelly, of Philadelphia; "Electro-Magnetic Basis of Physiology," by Prof. A. E. Dolbear, of Tuft's College, Massachusetts; "The Fundamental Relation of the Sinusoidal or Undulating to Other Forms of Current in Their Action on Nervous Tissue," by W. Y. Cowl, of Berlin, Germany; "Cases of Malignant Growth Treated by Electro-Puncture," by L. W. Reading, M.D., of Philadelphia; "Some Points in the Treatment of Stricture of the Urethra by Electrolysis," by Prof. W. H. King, M.D., of New York; "Electricity in Orificial Treatment," by C. A. Weihick, M.D., of Chicago; "Hypertrichoses and Its Treatment by Electrolysis," by J. L. Coffin, M.D., of Boston; "Notes on Electro-Therapie," by Drs. G. Gautier and J. Larat, of Paris; "Treatment of Procidentia Uteri by the Faradic Current," by G. E. Percy, M. D., of Salem, Mass.; "Electrical Treatment of Dysmenorrhœa," by Emily K. Bruce, M.D., of Boston; "A New Method of Dilating with Faradism," by Jeannie W. Martine, M.D., of New York; "Electricity as a Means of Diagnosis in Gynæcology," by Dr. G. Apostoli, of Paris; "Reports of Gynæcological Cases," by Minnie C. T. Love, M.D., of Denver; "Electricity in Diseases of the Pharynx," by T. L. Shearer, M.D., of Baltimore; "The Proper Application of the Electric Cautery for Nasal Diseases," by W. A. Dunn, M.D., of Chicago; "The Use of Galvanism in Diseases of the Larynx," by J. B. Garrison, M.D., of New York.

The following officers were elected for the ensuing year: President, A. B. Norton, M.D., of New York; vice-presidents, F. A. Gardner, M.D., of Washington, and Clara E. Gary, M.D., of Boston; secretary, F. M. Frazer, M.D., of New York; treasurer, J. B. Garrison, M.D., of New York; executive committee, Prof. W. H. King M.D., of New York, and W. L. Jackson, M.D., of Boston.

Electric Power Pumps for Water-Works.*

BY JOHN M. GOODELL.

Until within a comparatively few years, engineers engaged in designing systems of water-works where pumping was necessary were restricted to steam and hydraulic power to operate the requisite machinery. It is hardly necessary to say that such a restriction has proved extremely burdensome in many places. Good water powers are rarely to be found at sources of a good public water supply, and the latter can seldom be secured in such localities that the cost of hauling coal to them is not a considerable expense. The consequent desirability of economy in fuel consumption has led to the construction of several types of steam pumps which are certainly admirable pieces of mechanism. But even the steam pump in its best forms does not answer all requirements, especially for small plants. Where the volume of water to be pumped daily is small, the amount of coal burned is comparatively large for the work done, and the stations are usually built so far from the railways that by the time the coal is dumped in the shed it has proved pretty expensive. Consequently there has long been a feeling that a new method of pumping was desirable.

The Germans were probably the first to break away from the steam pump, which they replaced with a power pump driven by a gas engine. Duren was the first place to adopt such a combination, which was done in 1884, but the example was quickly followed by other cities, and there are to-day about fifteen water-works pumping stations in that country driven by gas, gasoline or oil engines in an apparently successful manner. The reason for the adoption of the gas engine was simply its economy. There is hardly a German town of any size without its gas works, which are frequently owned by the city and operated under the direction of the same engineer who superintends the water-works. The pumping stations are generally some distance from the railways, and in a number of places it was found on careful investigation to be cheaper to lay a gas main to the stations and put in gas engines than to erect a steam pumping plant. Germany is a country where the gas engine has been brought to a condition of remarkable efficiency, owing to the widespread availability of gas, and it is therefore natural that this motor should be selected to replace the steam engine. In several recent plants, gasoline, oil and producer gas engines have been installed to operate pumping stations, the choice in each case being due to the fact that the total cost of operating the plants with them, including interest and depreciation charges, was estimated to be less than with steam.

A great deal is to be learned from these German water-works, which have been described in a number of foreign papers. Pretty full translations of these articles have begun to appear in the *Engineering Record*, so it is hardly necessary to refer to them here at length. The earlier German power pumping plants were largely experimental, and in their operation a number of features capable of improvement were found. The least satisfactory point about them was the use of a comparatively long train of gearing between the pump and the engine. This transmitted power well enough, but it made altogether too much noise. It was necessary, however, on account of the little knowledge then had of the capabilities of the power pump. In the earlier plants these pumps had to be run at low speeds, but in the later works, triplex pumps making sixty to eighty revolutions a minute, about twice the speed of triplex pumps with 10 x 12 inch cylinders in this country, have proved noiseless and free from shocks. It was therefore unnecessary to retain the gearing, as the reduction in speed between the gas engines, making about 150 revolutions a minute, and the pump shaft, making sixty to eighty revolutions, was accomplished by selecting pulleys of suitable diameter, which were connected by leather or rope belting. The most suggestive fact to be learned from these plants, however, by an American engineer, is the value of careful attention in the design of the suction and air chambers of the pumps, details which are too frequently considered of minor importance, even on steam pumps. Mr. Max Munzol, engineer of the Otto Gas Engine Works of Deutz, attributes the success of many of the plants under consideration, especially the satisfactory running of the pumps at the speeds mentioned, to the proportioning of these chambers to the special conditions of each locality.

In this country we do not have a gas plant in every little village, but on the other hand, there are few American towns with any enterprise in them which do not have an electric lighting plant, or do not want one. It is hardly necessary to call the attention of the

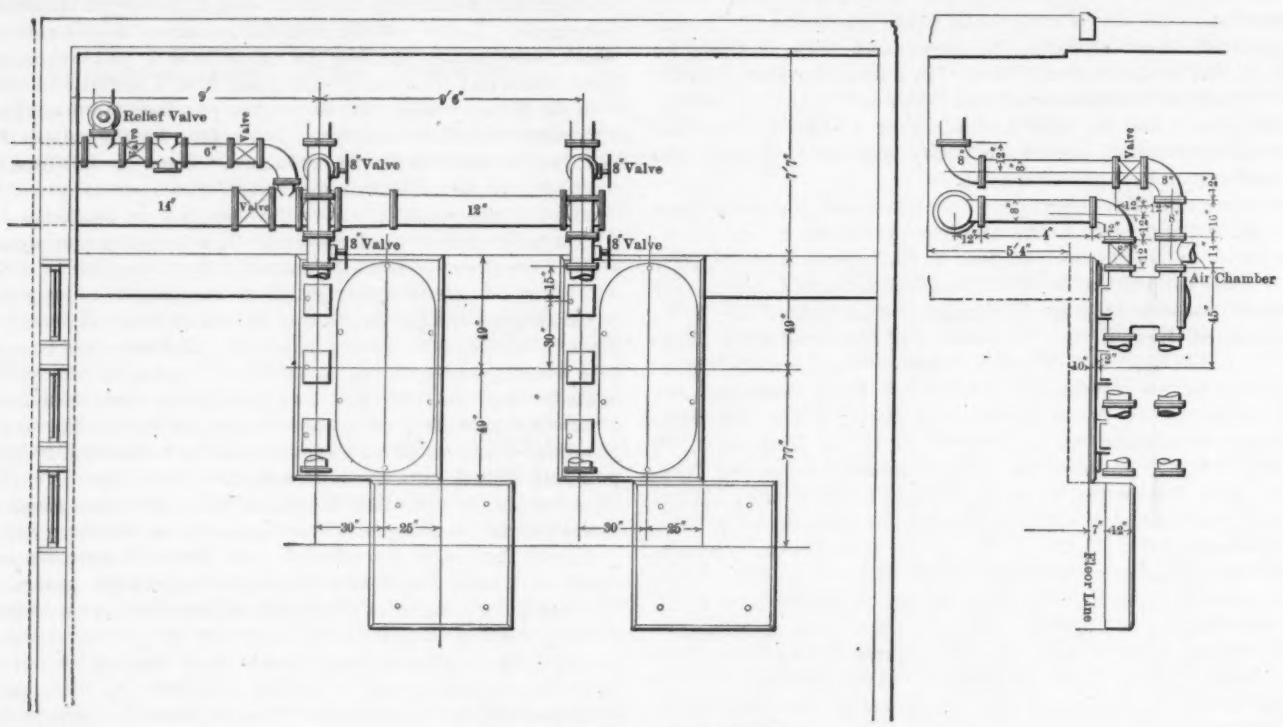
* A paper read at the Atlanta meeting of the American Water-Works Association.

members of this association to the large number of combined water and electric light plants, which are now proposed or in course of construction, and the object of this paper is merely to point out a method of designing the water-works part of such plant, which is somewhat novel and opens a field for economical construction and management well worth studying. Possibly, the best way of showing the capabilities of this method is to describe one of the few American plants already constructed in which it was adopted. The plant of the Monroe Water Works & Light Company, at Monroe, La., offers a good example, and its construction reflects much credit on the good business judgment of Mr. W. E. Hawks of Bennington, Vt., president of the company.

It was the original intention of the company to supply artesian well water. Three wells were sunk and all arrangements made for using them as a source of supply, but the consumers wanted river water, and it was therefore decided to give it to them. The electric light and artesian well station is about a mile from the river and is amply large enough to furnish the small amount of power necessary to pump all the water needed. To construct an independent pumping station on the river bank, as would have been absolutely necessary but a few years ago, was undesirable for many reasons, so it was decided to build a small power pumping station, operated by electricity from the main station. Moreover, as the river has a rise and fall of some 48 feet, it is necessary to adopt a special design for the entire pumping plant.

Two plans were possible by which the pumps could be operated. The first was to build a deep pump well, and the second was to build the whole station on a car which could be hauled up and down an inclined track, like a small ship railway. The second plan was adopted, and the use of an electric motor and triplex pump made the construction much easier than had a heavier and larger steam-pumping plant been necessary. The railway is nearly 500 feet long and was built on piles. The pumps are mounted on a car 28 feet long, 12 feet of which is occupied by the house sheltering the machinery, the rest of the car being used to support the suction pipe, which projects out from it into the water. The pump is of the triplex pattern, furnished by the Goulds Manufacturing Company, of Seneca Falls, N. Y., and has a capacity of 400 gallons a minute. It is connected by spur gears with a slow-speed, 15-hp Westinghouse motor. The car is hauled up the track by means of a wire cable and a hand winch at the head of the incline, and is clamped to the track at four places while the pumps are running. The current is supplied through No. 0 three-braid wire. The discharge pipe is fastened to the ties at one side of the track and is provided with 20 flanged and capped heads along its length, any of which may be connected with the pump. The current for the motor is supplied by the same 50 horse-power, 500-volt Westinghouse generator at the main station, which furnishes power throughout the town. This works is a small one, to be sure, but it illustrates very well the advantages which electricity offers. It is self-evident that a steam plant could hardly be built and operated so satisfactorily as the one which was constructed.

One of the earliest electric pumping plants in this country was built at San Antonio, Tex., for the local water company, to supplement two plants operated by water power and located some three miles from the business centre of the city. The electric plant was placed in the heart of the city, within a few feet of a 45-foot standpipe supplied by four 8-inch artesian wells. Three Gould's triplex pumps were installed, each having three outside-packed plungers of 10 inches diameter and 12 inches stroke, the whole plant having a capacity of 2,250,000 gallons in 24 hours. Each pump was provided with a separate suction pipe and valve, and discharged through a separate pipe and check valve into the force main running to the city distributing system, thus enabling the amount of pumpage to be adjusted fairly closely to the demand. Each pump was connected directly to a 30-hp C. & C. motor, taking a current of 500 volts from the lines of the local electric light company.



Plan of DeKalb Pump House.

Several features of this plant deserve attention as indicating some of the advantages of such works. It will be noticed that the old pumping plants were operated largely by hydraulic power some three miles from the city, while the new plant is located in the town. This means the elimination of a friction head 20 feet anyway and probably much more. Another thing to be noted is that there was no boiler plant at the new station. Whenever the pressure fell in the water pipes it was only necessary to turn one, two or three switches to throw as many electric pumps into service, and by opening the switches again the pumps were stopped. The electricity was not running to waste while the pumps were idle, and there was no banking of fires under boilers. All this means moreover that not so much attendance was required.

One of the latest plants of this sort is that at DeKalb, Ill., which has two 10x12-inch Gould's triplex pumps driven by two direct-connected General Electric motors. The plan of the pump house is shown in the accompanying cut. This plant was recently tested by Mr. Daniel W. Mead, and some figures from his report are appended as indicating the general efficiency of the station, although it should be stated that the apparatus was new and consequently stiff, and that the E. M. F. was not kept up during the tests, facts which naturally tend to lower the records materially. A test of one of the motors, which was furnished with a current of 200 to 220 volts, showed that its efficiency ranged from 83 per cent., while delivering 20 horse-power to the pump, to 92 per cent. while delivering 55 horse-

power. The tests of one of the pumps and its motor gave the following results:

Duration, mins.,	14	28	12	44	60
Amperes,	156	215.7	206.05	243.3	111
Volts,	193.4	192	195	186.8	203
H. P. furnished,	40.44	55.54	55.54	60.03	30.20
Total lift,	88.5	130	129.5	133.5	62
Revs. per min.	41.75	42.5	41.71	45.9	44.8
Combined efficiency of motor and pump	64.9	71.0	71.80	71.80	65.6
Pump efficiency	70.5	75.4	78.10	75.2	75.2

The slip of the pumps was calculated from indicator cards, and seemed to be 12 per cent. for the suction valves, and 0.9 per cent. for the discharge valves.

This station, like that at San Antonio, is instanced here as showing the utility of electric pumping machinery in places where current can be obtained from local electric plants. Such a pumping station occupies comparatively little room, requires the services of but one engineer on a shift, has no boilers to be fired, and can be put in instant service at any time by turning the proper switches. Its greatest drawback is the possibility of a sudden stop in the current supply from the generating station, and the importance to be attached to this possibility depends largely on the character of the station and of the men in charge of it.

Such works are not, however, the most promising field for electric pumping systems. Their advantages are most apparent when it is necessary to build works for a small place without water in the immediate vicinity. In such a locality the pumping station may be required several miles from the town and from a railway. If it were a steam plant, the annual cost of fuel delivered over rough roads to the station may be a serious matter. In such a place electricity offers an easy solution of the problem. As an example of what it will do, the plant at Canandaigua, N. Y., may be cited. This is still in course of construction, and it is therefore hardly proper to more than outline its features here. The power-station is conveniently located in the village, while the pump-house is at Canandaigua Lake, 3½ miles distant. Two of Gould's 12 x 12-inch triplex pumps are driven by a direct-connected, 100-hp General Electric motor. The three-phase system of transmission is to be used, and the current is to be furnished by a 100-kw generator at the power-station in the town. This generator is to be driven by an engine of 115 nominal hp.

It is for such a plant as this that electricity seems particularly suited. The advantage of putting the power house near a railway so that coal can be secured at a low rate is an important matter, and if an electric light plant is to be installed at the same time as the water-works, the use of power pumps is all the more likely to be profitable. The demand for water varies inversely through the 24 hours to that for artificial light, and this makes the design and economical management of such a combined plant so much the easier. The writer does not mean to say that such a station will be suited to the local conditions of every town wanting water and electric light, but he does believe that a town will make a mistake in adopting independent plants for such purposes without securing estimates of the cost of building and running a combined station.

Another promising field for electric pumping is furnished by small high-service districts which have to be supplied by special pumping apparatus of small capacity. Still another use to which they may be put in some cities covering a large flat area and supplied with water from one or two main sources, is to serve as "relay pumps," similar to the relays used on oil pipe lines. These are located at a considerable distance from the main pumps at places where the friction head in the pipes has reduced the pressure materially, and raise pressure by taking water from the main pipes, and forcing it along through them under a greater head. In this way the pressure on the pipes before and behind the relay station is increased.

Winter Trolley Parlor Cars.

Although the Brooklyn Heights Railway Company has had special cars for trolley parties in service but a short time this year, the management is convinced that by their use and operation a considerable amount of new business can be attracted. The company has decided to furnish trolley party cars for Winter use. They will be closed, furnished with easy chairs and rugs and rich hangings. They will be finished in hard woods and plate glass mirrors, and no money will be spared to make them attractive.

An Improved Illuminometer.

In a paper read before the recent Ipswich meeting of the British Association, Messrs. W. H. Price and A. P. Trotter describe a form of illuminometer modified from several previous forms devised by one or both of them. The original type was described before the Royal Society in 1883. This consisted of a box blackened within, over the end of which was stretched a Bunsen screen of paper having a grease spot in the middle. At a distance of 12 inches was another screen of drawing paper. The grease spot was so screened that no light fell upon it except that which was reflected from the drawing-room screen. At the end of the box opposite the Bunsen screen was an eyepiece consisting of a plain tube. Within the box a small glow lamp was fixed, and in order to make a measurement of the illumination of the drawing-paper screen, the current through the lamp was varied by a rheostat until the grease spot was invisible.

The authors state that the only defect of this illuminometer was the yellowish and reddish color of the lamp when dimmed for low readings.

In 1884 the authors designed a portable illuminometer in which the lamp could be moved toward or withdrawn from the Bunsen screen, and a mechanism was provided by which, when a pointer moved a certain distance over a uniformly divided scale, the displacement of the lamp was as the square of that distance. The Bunsen spot was viewed by Rudorff mirrors in the usual way. This instrument worked well, but the range was small, and could not be easily increased. The lamp would have to be moved to a very considerable distance from the screen for measuring the feeble illuminations met with in street lighting. Eight years later one of the authors experimented with modifications of this instrument, and found that in ordinary street lighting the illumination is often only equal to that due to one candle at 14 feet distance. A large number of different methods of reducing the light were tried. Many combinations of lenses, the eclipsing device used in dissolving views, photographically shaded glass screens, and other devices were used, and finally a white reflecting screen was inclined at different angles to a small electric lamp; and on this principle a photometer was constructed in February, 1892. It was found that the Bunsen screen could be replaced with advantage by a simple white cardboard diaphragm, pierced with one or more holes. The illumination of this diaphragm, generally in a horizontal position, was the illumination to be measured. Below this was the reflecting screen, enclosed in a box about 2 feet by 6 inches by 5 inches, with a pair of small glow lamps and a secondary battery. The screen could be inclined toward the glow lamps by means of a chain wound up on a cam mounted on a spindle, the cam being formed so as to give an open scale. A hand or pointer on the spindle indicated readings on a dial.

During the present year an improved form of this illuminometer has been constructed. The chain and cam, which allowed the instrument to be used only in a horizontal position, have been replaced by a system of levers. The object of these levers is to give an open scale. If the motion of the pointer were proportional to the angular movement of the screen, the scale would be approximately a scale of cosines. The instrument is shown in Fig. 1 with the lid open and the front let down. It measures 1 foot 3¼ inches by 5½ inches by 9½ inches high. On the end to the left there is a red glass window, and immediately within are two 12-volt lamps

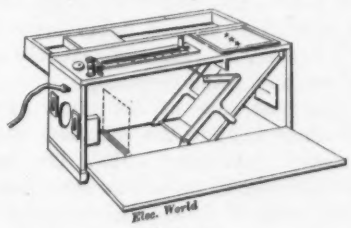


FIG. 1.

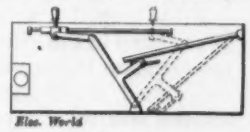


FIG. 2.

(one of which is shown in Fig. 2), one of about 1 cp and the other of 2 cp. It can be seen through the window if either or both of the lamps are alight. The lamps are held in special lamp-holders, capable of adjustment as to height by clamping screws. These clamping screws and the base of one of the lamp-holders are shown in Fig. 1. A switch on the top of the instrument enables either or both lamps to be turned on and off. At the other end of the box the reflecting screen is hung. The middle of the screen is about 11 inches from the lamps. It is shown in Fig. 1 in the lowest position. In Fig. 2 the screen and one of the levers, together with one of the rollers on which the screen rests, and the handle by which it is moved, are

shown with the screen in its highest position by full lines, and in its lowest position by dotted lines. In its highest position the filaments of the lamps are a little below the plane of the screen, no direct light from the lamps then reaches the screen, and it is only faintly illuminated to about $\frac{1}{200}$th of one candle at a foot, by stray light, which is excluded as much as possible. The diaphragm is placed horizontally immediately above the hinged screen. Three small star-shaped holes are cut in it, and through them the illuminated reflecting screen can be used. A handle carrying a pointer moving over a graduated scale controls the inclination of the screen by means of the levers and links. A guide, attached to the back of the screen (shown in Fig. 5), allows the instrument to be turned on its side without interfering with the working. In order to take a measurement, one or both of the lamps are turned on, and the handle is moved until the screen seen through the holes in the diaphragm matches the diaphragm in brightness. If the color of the light outside is about the same as that of the lamps, the middle hole may be made to disappear. The observer should stand approximately in the vertical plane passing through the three holes, so that he may see that part of the screen through them which lies immediately beneath them.

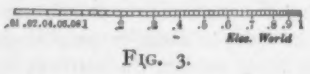


Fig. 3.

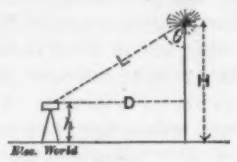


Fig. 4.

Various substances have been tried for the diaphragm and screen. Thin metal painted with a whitewash made of magnesia and isinglass is perhaps the best; the diffused reflection practically follows Lambert's cosine law, but the material is easily soiled and cannot be cleaned. Bristol board from which the glaze has been removed by a damp cloth closely follows the cosine law within the angular range required in this case. It is important that there should be no glaze on the surface of the hinged screen, since the inclination of the lamp to the screen and of the screen to the eye for maximum illumination is about 45 degrees. But as the scale is graduated by experiment, a slight departure from the cosine law does not matter. On the other hand, it is of greater importance that the screen should be very smooth and flat. Under very feeble illuminations, the light from the small lamp making an angle of incidence very nearly 90 degrees, minute irregularities are easily seen, and make accurate readings difficult. For ordinary street lighting and for general industrial photometry a slight departure from the cosine law on the part of the diaphragm is of no practical consequence, so long as there is no perceptible glaze, for it is always observed nearly vertically and never at a large angle of incidence.

The color difficulty is reduced, in the first instance, by the freedom of motion of the levers. The handle may be quickly moved to and fro on each side of the true reading, and the middle position may be estimated. In measuring the illumination due to arc lamps, the color difficulty becomes troublesome. The color of the glow lamp in the photometer should be approximately a mean between the color of the standard of light wherewith the instrument is calibrated, and that of an arc lamp. This halves the difficulty, which can never be entirely removed, since differently colored lights are not physically comparable; it may, however, be relegated entirely to the laboratory by the use of a colored screen and diaphragm.

If the hinged screen be tinted pale blue, some of the yellow rays of the lamp in the photometer are absorbed, and the reflected rays approximate to gray—that is, to feebly illuminated white. On the other hand, if the diaphragm is tinted yellow, the white light from electric arcs, or of daylight, may be reduced to approximately the same color as that of the lamp in the photometer. In the first case the brilliance of the hinged screen is reduced, and a brighter lamp would have to be used to restore the true value of the scale readings; and in the second case the brilliance of the diaphragm would be reduced, and the scale readings would be too high. But by tinting both screens the calibration of the instrument need not be disturbed.

To find the slant height at any distance, the height of the light being known: divide the height of the lamp above the photometer by the cosine of the angle of incidence; the quotient is the slant height required. Or the horizontal distance may be measured and the square of this distance added to the square of the height of the light. This gives the square of the slant height.

To find the candle-power, the illumination in units of a candle at a foot being observed, the light from other lamps being carefully screened, the slant height being known: multiply the illumination by the square of the slant height, and divide by the cosine of the angle of incidence.

On hilly ground it is necessary to know that the height of the lamp above the photometer at each point of measurement. It is best, in that case, merely to record the angles, and afterward to find the tangents. The horizontal distance between the photometer and the lamp post, divided by the tangent, gives the required height. It may be observed that when the square of the slant height in feet is equal to the cosine of the angle of incidence, the scale graduated in units of a candle at a foot becomes a scale of candle-power, and when the square of the distance in feet is 10, or 100, or 1,000 times the cosine, the multipliers 10, 100 or 1,000 may be used to convert it into a scale of candle-power. The square of the slant height being known, the photometer may be tilted until the required cosine is indicated by the shadow of the pin. If the slant height is measured by the sum of the squares of the horizontal distance and the height, the square is at once obtained.

The illuminometers are calibrated either by standard candles, or by sub-standard glow lamps supplied from secondary batteries, or by the amyl-acetate standard lamp or Hefner unit. This standard, which is well recognized in physical work, is 0.877 of a standard candle, or a standard candle is 14 per cent. more than an amyl-acetate lamp. Placed at one foot distance from, and perpendicular to the diaphragm, the photometer being placed on its side, the illumination is 0.877 of a candle at a foot. If it is brought to a distance of 11¼ inches ($\sqrt{0.877}$ feet), it is equivalent to one candle at a foot. But this distance and position is inconvenient. If it is placed at a distance of one foot, and at an angle of 55° 10′, the illumination on the diaphragm is one half of a candle at a foot, since cosine 55° 10′ = 0.57, and $0.57 \times 0.877 = 0.5$. A mark is therefore made at this angle on the quadrant, and is inscribed, H. U. = ½ cp.

Considerable experience with the use of small glow lamps supplied from portable secondary batteries has given us great confidence in this kind of secondary standard of candle-power. The battery is always freshly charged before each evening's work, and is discharged for half an hour before use. The lamps are only turned on while an observation is being taken.

The 1893 photometer was arranged to be held in the hand; the 1884 photometer stood on a tripod about 2 feet 6 inches from the ground. The street measurements made in 1892 were all made with a photometer placed on the ground, the diaphragm being about six inches from the pavement. The proper height for an illumination photometer is a matter of opinion. When the photometer is placed on the ground the large number of measurements required for a thorough photometric survey of a street or empty building can be quickly made. For some purposes—for example, in an exhibition or a church—a stand is necessary; the calculations of candle-power then become rather more tedious.

The various observed and computed quantities may be expressed as follows: Let D = horizontal distance from photometer to lamp-post (see Fig. 4); L = slant height from photometer to light; H = height of light above the ground; h = height of the photometer diaphragm from the ground; θ = angle of incidence; c/f^2 = illumination of units of a candle at a foot; cp = candle-power, then

$$H - h = D/\tan\theta;$$
$$L = [H - h]/\cos\theta = \sqrt{D^2 + [H - h]^2};$$
$$\text{candle-power} = (c/f^2 \times L^2)/\cos\theta.$$

The following is an example of the measurement of the illumination and candle-power in the case of a street lamp:

D	θ	c/f^2	$\tan\theta$	$\cos\theta$	$H-h$	H	L	L^2	$c/f^2 \times \cos\theta$	cp
20	66°	0.025	2.25	0.407	8.9	11.9	21.8	475	0.0614	29

The screen being colored pale blue and the diaphragm pale yellow, there is no difficulty in obtaining disappearance of the hole in the diaphragm when illuminated by arc light or even by daylight. The selection of the colors suitable for obtaining a true measurement is based upon the mean of a number of measurements. White screens are used, and the comparison should be made in a building illuminated by a number of arc lamps. A number of measurements are made with quick oscillations of the handle, and the mean is taken. Several screens and diaphragms of different tints being in readiness, pairs are tried and a selection is made of a pair which give a good color match, and, if possible, the mean reading given by the white screens. A slight departure from the mean could be corrected by

the use of a coefficient.* It is not suggested that strongly colored lights can be scientifically compared in this manner, but only that the yellowish light of a glow lamp may be compared with the whitish light of an arc or of subdued daylight. Messrs. G. W. and M. R. Patterson, the translators of Palaz's "Industrial Photometry," have said this device "can, of course, give no additional absolute accuracy to the photometric measurements; it, however, adds greatly to the comparative accuracy of the results, as it makes it possible to measure relative intensities under various conditions with great precision." But it should be observed that the selection of the tints may be made at leisure, and under favorable laboratory conditions, and by thus avoiding all color trouble during ordinary use of the photometer, a very considerable gain in precision is secured.

The scale is 5½ inches long, and is shown in Fig. 3. With the smaller of the two lamps the highest reading is equivalent to one candle at a foot; with the larger lamp it is twice this illumination. The oscillations of the handle generally extend at first over two scale divisions, and after three or four oscillations their amplitude may be reduced to about one scale division. The half of a scale division may be estimated, except at the highest part of the scale, which is slightly contracted. The precision is about 2 to 3 per cent. The contraction of the scale at the upper end is intentional, and is caused by the arrangement of the levers.

In case of renewal of the lamps it is very important that other lamps should be placed in exactly the same optical position in the photometer, otherwise the scale would have to be recalibrated. In order to fix the height of the lamps, which is the only adjustment necessary, a sheet metal screen, shown by dotted lines in Fig. 1, is placed in a holder attached to the floor of the photometer. Two small holes are drilled in this screen, and a white paper screen, having a black horizontal line, is fastened to the end of the box, (see Fig. 1) opposite to the lamps. The hinged screen being lifted by the levers out of the way, "pin-hole images" of the filaments are thus thrown on to this screen, and the lamps being set so that the single horse-shoe filament appears nearly closed up (see Fig. 2), the dark line between its two limbs is made to fall on the black horizontal line. The images being magnified, considerable accuracy is possible.

Although the principal object of this photometer, as of those which preceded it, is the measurement of illumination, it is sometimes desirable to measure the candle-power of a lamp in a street without removing it from its position. By the use of a graduated arc such measurements can be made with the present photometer. A quadrant is fastened to the side of the photometer, and a pin at the centre from which the quadrant is struck acts as a gnomon. A spirit level on the top of the instrument being adjusted, the angle of incidence may be read in degrees on the quadrant, and at the same time the cosine of this angle may be read on an adjacent scale. It is necessary to find the slant height or direct distance from the source of light to the photometer.

To measure the vertical height of the light, set the photometer so that the shadow falls on 45 degrees. Measure the distance from the pin to the lamp horizontally, and from the pin to the ground vertically. The sum of these distances is the height of the actual source of light. This can be measured to about 2 per cent., say 3 inches in 12 feet 6 inches.

*Owing to the Purkinje effect, an exact color match cannot be maintained throughout the whole range. The holes in the diaphragm look yellowish under strong illumination and bluish under feeble illumination.

Magnetic Units.

The London *Electrician* of Sept. 13 contains a further installment of letters on magnetic units and a lengthy editorial on the same subject, all of which are abstracted below.

Dr. Lodge says it is easy to exaggerate the oddness of a new name, so long as it is unfamiliar, and he remembers that at one time the *ohm* suffered under this disadvantage; now, however, the name sounds homely enough. Although the term does not convey its meaning on the surface so clearly as the equivalent *volt-per-ampere* may be supposed to do, this fact, so far from being an objection, is a positive aid toward its free and easy diffusion among operators and line testers, and the same applies with reference to the *watt* and to the *volt-ampere* and the *joule* and *volt-sec-ampere*. He considers that it is a short-sighted policy to enforce *ampere-turn* instead of *gauss*, because it will then be difficult to proceed further with the formation of compounds, such as *weber-per-gauss* and *weber-gauss*. Prof. Lodge considers that the term *weber-turn* seems likely to become in the future nearly as useful as *ampere-turn* has proved to be, but it cannot be introduced unless a single name is affixed to the C.G.S. unit of flux. Referring to those who appear to hold that no unit names at all are wanted, Dr. Lodge thinks they can hardly remember the vague era before the terms *volt* and *ampere* existed. He believes it has not been clearly noticed by everybody that the unit is just as important a portion of the specification of a concrete quantity as the numeral part.

Mr. Geo. Fras. FitzGerald writes that he cannot understand the objection against having names for any units at all, and hopes that the question at issue will be reviewed from an international standpoint. Even in the one matter of magnetic force he points numerous names as growing up, such as *lines* and *scots*, and *gausses*, and *thoms*, and *hops* and *mags*. While there are objections to personal names he considers that as this has been a matter of international agreement, it will probably be best to abide by that decision and continue the system, although it is a very good rule to avoid the names of living men. Mr. Fitz Gerald believes that we really want different names for the units of self-inductance and magnetic permeability, and thinks it would be a great misfortune if the B. A. were to undo the work of the Chicago International Congress with respect to the *henry*. He agrees with Mr. Heaviside in thinking that it is a great misfortune that our units have been founded on the present definitions of a unit pole, but does not at all agree with him in thinking that a change is possible now.

Mr. G. L. Adambrooke introduces his letter with a personal account of himself since leaving school, and, after reviewing several books, says that he feels more and more the absolute necessity of a clear understanding and definition of electromagnetic quantities and actions. To introduce certain units to define magnetic quantities does not, in his opinion, introduce complication, but gets rid of it.

The *Electrician* introduces a long editorial on the subject of magnetic units with a review of the work of the Chicago Congress and the American Institute of Electrical Engineers in this connection. It approves of the selection of the name *weber*, but thinks that it would have been distinctly better to have reversed the use of the two names, *gilbert* and *gauss*. The reasons given are that the *volt* is of one syllable and the word *ampere* of two syllables, and therefore the two magnetic names that correspond should, preferably, also be of one syllable and two syllables, respectively. Like the word *volt*, which lends itself to the allied distributive *voltage*, so the word *gauss* lends itself to become the distributive *gaussage*, which the word *gilbert* does not. Also, just as the electrical circuit of unit resistance requires an E. M. F. of one volt to produce one ampere, so in a magnetic circuit of unit reluctance it requires one gauss to produce one weber. The *Electrician* understands that the term *gauss* has been already used as the name of the unit of M. M. F. at the Central Institution of London.

While the *Electrician* is inclined to believe that Mr. Heaviside is right in attempting to get rid of the difficulty connected with 4π, it also believes that in a world of practical issues and commercial interests, systems and of men of business, we cannot afford, even for the sake of the more enlightened generation that will follow, to contemplate such a revolutionary measure. It points to the correspondence in its columns as indicating some need for names to fit units actually in use, this view being supported by the present employment by some engineers of *kilo-lines*, *mega-lines*, *thoms* and *kapps* with relation to magnetic flux. While objecting, therefore, to the wholesale creation of fantastic names, and units of more than doubtful utility, it is ready to admit that something like a case has been established for recognizing by a definite designation the unit of magnetic flux, and favors calling the C. G. S. unit either weber or *line*.

As to the unit of M. M. F., no new name is thought to be needed, as the ampere-turn is itself the name. In regard to a third unit, whether it be the unit of reluctance or permeance, it is considered that there will be time enough to devise a name for it when its magnitude shall have been decided upon. The editorial repeats the argument against confounding $\mathfrak{B}$ and $\mathfrak{H}$, stating that although we may express by similar numbers the effect, $\mathfrak{B}$, of applying the cause $\mathfrak{H}$, it does not follow that the quantities are of the same order or should be expressed in terms of the same unit. It adds, however, that unfortunately we have dropped into applying the notion of lines per square centimetre to express both the effect and the cause, but considers that we should now discriminate, before christening a unit, as to when, by whom and how often such a unit is likely to be used.

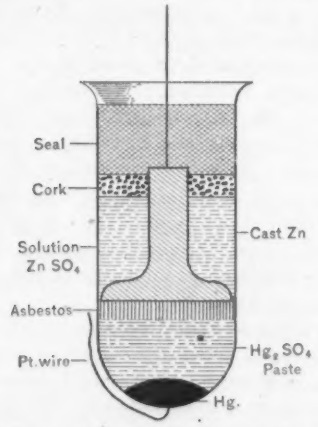
The editorial concludes as follows: "Ours is no mere policy of *laissez-faire*. The criticisms we have passed from time to time on the proposals of our American friends, and of our correspondents, have been written in no spirit of captious carping. We are above everything desirous that our progress should be solid; and that therefore we must be willing to proceed slowly, and on the lines which the actual working pioneers in the ranks of the profession indicate as lines of utility. And thereafter, to whatever is once settled we must doggedly adhere. There must be no more idea of changing the *henry* than of altering the *ampere* or the *ohm*. It may not be much use now that we have got it; but there it is, and we will not consent to tinker with either the unit or its name. New units, if and when they are really wanted. New names only if old ones do not already exist. But no jerry-building of fancy units, and no tinkering."

A Portable Clark Cell.

BY HENRY S. CARHART.

The form of Clark cell adopted as a legal standard by act of Congress, is the modified H-form, designed by Dr. Kahle, of Berlin. This form as a primary standard I recommended to the committee of the National Academy of Science as preferable to the one adopted by the English committee, chiefly for the reasons that it contains no foreign material, such as cork, to affect the E. M. F., and a saturated solution of zinc sulphate is always in contact with the zinc amalgam. In the English test-tube cell the zinc rod dips down into the solution and its upper portion is often in a less dense solution than the lower end. That this is so I have demonstrated by letting such cells stand for long periods, and in every case zinc has been removed from the rod near the surface of the solution and transferred to the lower end, where it was deposited as a ring or enlargement.

I have found it possible to so modify the test-tube form as to make the cell portable and still free from the above objection. The materials correspond precisely with the legal requirements. The cell is illustrated in the cut with a single point of difference to be noted. The zinc is cast with a foot which nearly fits the tube, and this foot holds down the purified asbestos, so as to prevent the displacement of the mercury and the mercurous sulphate during transportation. Only a single thin slip of cork is used, and this is specially prepared and finely boiled in paraffine. The point of difference between this cell and the cut is that the zinc stem is turned down so as to leave the foot as a flat plate. The stem is then covered with a glass tube, cemented to it by a non-conducting wax. Fine crystals of zinc sulphate are mixed with the mercury salt and more are placed on top of the zinc plate. Thus the zinc is in contact with liquid only at the bottom of the solution and in the presence of the crystals.



Portable Carhart-Clark Cell.

This cell is rather troublesome to set up, but with proper care and skill a cell can be made which has none of the objections of the English form, except the presence of the cork, and moreover it is portable. One of these cells was compared with one made in accordance with the legal instructions, and the relative E. M. Fs. were represented by the following numbers:

Legal form	9808.3
Portable form	9808.6

Even this minute difference, which can hardly be measured with accuracy, may have been due to a slight difference of temperature, or to the well-known lag of the E. M. F. behind temperature changes.

Different Methods of Operating Electric Railway Motors.

The current issue of the *Transactions* of the American Institute of Electrical Engineers contains the discussion on Dr. Duncan's inaugural address delivered at Niagara which includes some remarks by Mr. C. P. Steinmetz, considering at length the different methods of operating electric railway motors. The systems are as follows:

1st. The continuous-current system; 2d. The continuous-current motor operated from an alternating main line by means of rotary converters; 3d. The alternating-current motor. Mr. Steinmetz proceeded to investigate the limits of application of these different systems, and determine in which case the one, and in which case the other, is preferable.

All electric roads, as far as they are in operation to-day, he said, or as we expect to see them introduced in the near future, belong under the following classes:

1st. *Surface roads in the interior of cities.*—On these roads the continuous-current railway motor with overhead trolley and ground return, operating at a potential of 500 or 600 volts, is used practically without any exception. Only a very few roads use either an underground conduit or a double trolley. On city surface roads there is at present no hope of seeing the continuous-current motor replaced by any other method of electric propulsion, since the continuous-current motor has proved itself entirely satisfactory under the conditions of such a road, and the distances are such that they can easily be reached by 550 volts, or a three-wire system, with 1,100 volts between the outside wires. The double trolley required with alternating-current motors practically excludes them from such roads with many switches and cross-overs.

Only in underground conduit roads can the alternating-current motor be expected to find an application on city surface roads. The double trolley in this case is no objection, since conduit roads operate usually with double trolley, and the alternating-current system offers in this case the advantage of permitting very low voltage at the trolley lines, due to the possibility of feeding by stationary transformers. Thus we may expect to see the alternating-current motor introduced on conduit roads.

2d. *The second application of the electric motor is to elevated roads.*—Here the continuous-current series motor is just being introduced, and there is hope at present of replacing it with the alternating motor, due to the particular nature of the elevated road service, where trains never run at full speed. Take as an instance the Manhattan Elevated road in New York. Excluding express trains, a train on this road never runs at full speed, because before it has reached that point it has already approached so near to the next station that it has to slow down. It is very readily seen that the alternating-current motor, while it can operate at its proper speed with very high efficiency, and can get any starting torque desired, nevertheless does not give this flexibility of speed, but while accelerating, has to run on the rheostat, and thus does not give the same efficiency as the continuous-current motor under the same condition. For this reason the alternating-current motor is less suited for elevated roads, the more so, since the main advantage of the alternating-current system, the opportunity of feeding by means of stationary transformers, is of no essential value for elevated roads which are of moderate length, and have a very heavy traffic; and where it is thus possible, with a comparatively small investment, to feed the road by continuous current at 500 to 700 volts, or even more, from one or a few power stations. Thus, these two fields of application will be held by the continuous-current motor for a long time to come.

3d. Another field in which the electric railway motor is rapidly gaining is in the *suburban and interurban traffic*, or those lines which extend from the city roads far out in the country, or connect adjacent cities, as for instance the network of railways stretching out from New York City along the Hudson and East Rivers, or from Boston out to Lynn, Salem, Dorchester, etc.

If the length of these roads becomes considerable, it will be impossible to feed by continuous currents from one central station, and thus some other method becomes necessary. Either you have to put frequent power stations along the road, which is, to say the least, awkward and inconvenient, or you have to use alternating current, and in the latter case two possibilities exist: either continuous-current motors on the cars, supplied by rotary converters from alternating main lines, or alternating motors on the cars supplied by stationary transformers. Both of these methods offer advantages and disadvantages.

The *system of rotary converters* has the advantage of allowing

the use of a standard continuous-current railway motor which is able to run over the city lines also, so that the same cars and motors can be used on city surface roads and suburban and interurban roads, the rotary converter merely taking the place of a supplementary central station. However, in general the speed at which the suburban roads are operated will be higher than the speed of city roads, and thus for this reason special motors, that is, special cars, will be required. Furthermore, the use of a commutator makes it desirable not to exceed 500 to 600 volts at the motor. This voltage means a frequent use of rotary converters along the road, which is objectionable, since the rotary converter, being a revolving machine, requires some attention and supervision—that is, in reality constitutes a sub-station.

The *alternating-current motor* has the disadvantage of requiring a double trolley. This may not be very objectionable on suburban roads with few switchings and crossings. It has, however, the essential advantage of running at a fairly constant speed, independent of the load, and will not race when running down hill, but will in this case return the power as generator into the line; nor will it slow down when climbing hills. This is quite a valuable feature in single-track roads, where at present with the continuous-current motor the car going down hill has usually to wait on the switch for the car going up hill. Furthermore, the alternating-current motor is more reliable in its operation, and since the alternating main current enters the motor field only, which is stationary, a higher voltage is permissible; that is, a greater distance between the supply transformers. The main advantage, however, is the possibility of feeding the line by stationary transformers, which need no supervision, but are to be considered merely as a part of the feeders. Thus, on these roads, wherever it is not absolutely essential to run the same cars over continuous-current city roads, the use of alternating-current railway motors on the car, supplied from an alternating-current trolley line, will be preferable to the system of rotary converters.

4th. A further field for electric railroading is to be found in *high speed, long-distance roads* for mostly passenger traffic, connecting important cities. Thus far nothing has been done in this line, although considerable discussion has taken place. Mr. Steinmetz was sure that the future will bring such roads. It is obvious that in this case only alternating-current motors are applicable, mounted directly on the axles and fed from high-potential mains by transformers. The speed of these roads must be very high, since steam locomotives have already reached a speed of about 100 miles an hour, and there would be no demand for the electric motor if it did not offer an essential advantage over the steam locomotive, and such advantage can only be found in the possibility of using very high speeds, due to the absence of reciprocating motion. Thus speeds of 150 miles per hour maximum, with an average speed of 100 to 120 miles per hour, will be just as safe as the present steam locomotive speeds.

The objection has frequently been raised against the alternating-current motor for railway service, that it does not give sufficient starting torque. This objection holds no longer, for the starting torque of alternating induction motors—for instance, of the three-phase type—far exceeds that of the continuous-current motor. Theoretically this is easy to understand. The torque of a motor—starting torque as well as running torque—is proportional to the product of armature current into field magnetism. In the continuous-current motor at normal running, the field must be fairly near saturation. Thus an increase of field magnetism is possible to a limited extent only, and an increased torque, therefore, requires a nearly proportional increase of current. In the alternating-current motor, however, the field is very far from saturation at normal running, and thus can in emergencies—as when starting on a curve or when climbing heavy grades—be doubled and tripled. Therefore, to get four times the torque in the alternating-current motor, by doubling the field strength, only twice the current will be required, while the continuous-current motor probably requires three or more times the current.

Furthermore, the production of heat in the alternating-current motor is distributed over the whole apparatus, and thus a much greater heat can be taken care of for a limited time.

Fig. 1 gives the testing record of a car equipment with two three-phase induction motors. They are designed to operate with the same speed and are of about the same size and weight as the standard General Electric Company's continuous-current railway motors, G. E.-800. They are controlled by a method devised by Mr. Steinmetz, and whereby it is possible to operate them at full efficiency and half speed as well as full speed, thereby offering the same advantages as the series-parallel control of the continuous-current railway motor. The curves *A* denote current per line required by this motor when operating at its rated voltage of 100 volts between the lines. The curves *B* give the efficiency, including bearing and gear friction. The curve *C* gives the speed—all as function of the drawbar pull, or pull at the periphery of a standard 33-inch wheel. The normal rating of these motors is 800 pounds drawbar pull per motor, or 1,600 pounds per car. As may be seen, in concatenated control, at half speed, the drawbar pull rises to 1,600 pounds, and at full speed to over 2,800 pounds, while by means of an emergency switch which changes the field intensity of the motor, the maximum drawbar pull can be increased to over 8,000 pounds; that is far beyond the heating limit of the motor and far beyond the pull which will slip the wheels. That means, in other words, that the alternating-current motor can give any starting torque which possibly can be required, just as well as the continuous-current series motor.

In closing this discussion Dr. Duncan said that perhaps the uses of the different methods and their limitations were correctly stated by Mr. Steinmetz. But he did not care to take up the question. He thought we could offer the steam railway people systems that would operate their passenger traffic more economically than it is now being operated. But the question to consider was, whether they are in a condition to accept the offer? There are only a few roads in the United States that are in a condition to accept the electrical benefits we can give them, because no two-track road, without disorganizing its traffic, can get the advantage of electrical transportation. We cannot at present change the method of freight transportation. Dr.

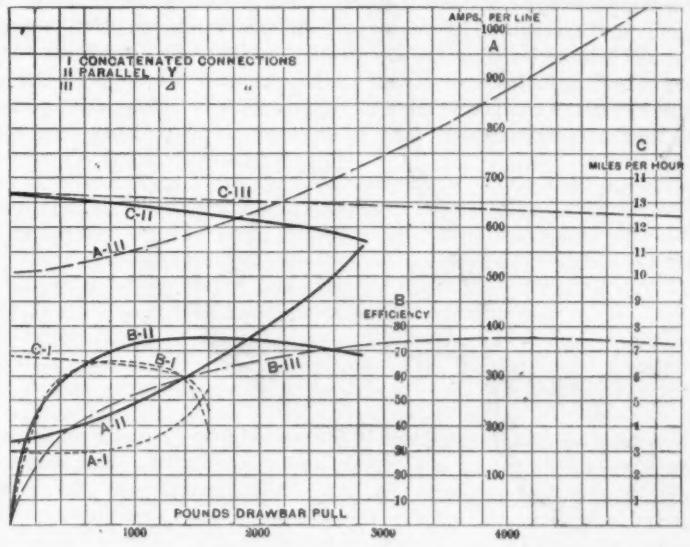


FIG. 1.

Duncan said he was not considering what is going to happen in the future, but the conditions as they exist at the present time. You cannot disorganize the freight traffic, you cannot disorganize through traffic, and with those two kinds of traffic on two tracks, you cannot possibly compete with a parallel line running a regular tramway service. It is not a question of which way we want to equip those tracks, but the thing is that the steam people must give us the tracks to equip, and to secure the benefits of electrical traction we must have four tracks on through roads, and even with four tracks some roads will find it difficult to equip.

We cannot compete for freight traffic by electricity except by using self-contained electric locomotives, in which the electrical apparatus is a mere gearing between the steam and the axle. As far as the principle goes there would be no difference in the character of the service between this and the ordinary steam equipment. But a freight traffic by a trolley system will not be as cheap as the steam traffic. At the present time the condition of affairs is this: The steam roads must compete with the electric roads that are paralleling them, and which are cutting down their receipts, and this can only be done by giving separate tracks for the electric service or by controlling competing roads. As Mr. Steinmetz says, there are a number of ways in which we can equip the roads electrically. Although he has projected a little into the future, yet he has pretty well stated the kind of service we ought to have on the different kinds of roads. But at the present moment, even if he were prepared to sign a contract for any one of the different types of equipment on any of the

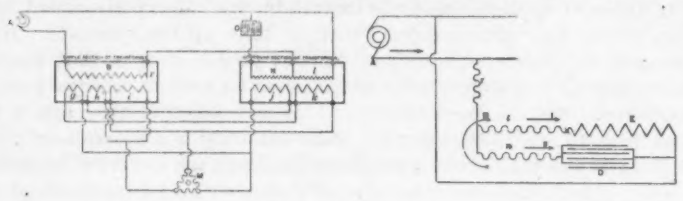
different types of road, there are not three or four steam roads in the United States that are prepared to take advantage of it, which was the point taken up in the inaugural address.

Phasing Transformers.*

BY CHARLES S. BRADLEY.

The following is a description of an arrangement of condensers and cores to produce polyphase and single phase alternating currents. Many different arrangements of condensers and inductances have been tried, and all have failed to keep their phases at a working relation, except the one about to be described.

A diagram of the phasing transformer and connections with the generator and motor will be found in Fig. 1, *A* being the generator, *B* the simple section of the transformer, *D* the condenser, and *M* the motor; *r*, primary of the simple section of the transformer, *n*



Figs. 1 and 2.

and *l*, primary of the compound section; *g*, *h* and *i*, secondaries of the simple section of the transformer, and *j* and *k* secondaries of the compound section. The primary of the simple section of the transformer is in series with the compound section and condenser. By the proper adjustment of capacity and inductance the magnetic flux in the core of the compound section is approximately 90 degrees in phase behind the simple section, then, in order to get three phases from the

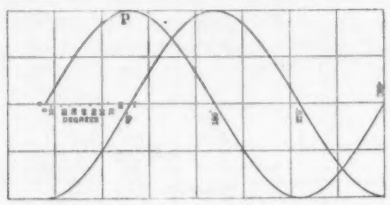
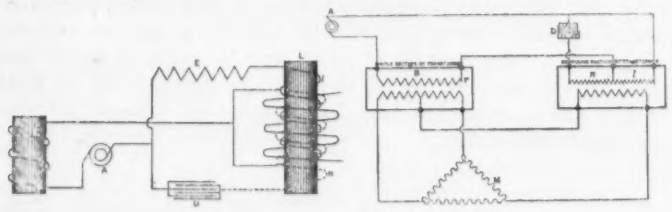


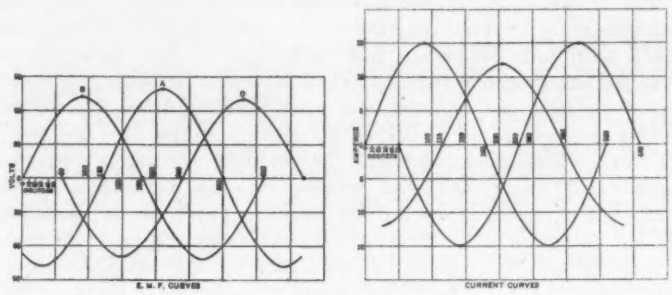
Fig. 3.

two, resort is had to resultants in the secondaries: *g* and *k* constitute one phase, *h* and *j* a second, and *i* the third. The essence of this invention rests in the arrangement of the compound section of the transformer and condenser. In order to explain the theory involved in this, refer to Fig. 2, in which *A* is the generator, *E* the inductance, *D* a condenser or capacity *l* and *n* represent the leads to the inductance *E*, and to the capacity *D*. If the generator is generating an E. M. F. in the direction of the arrow, Fig. 2, a current will flow through the lead *l* and the inductance *E*, as represented by the arrow prime, and



Figs. 4 and 5.

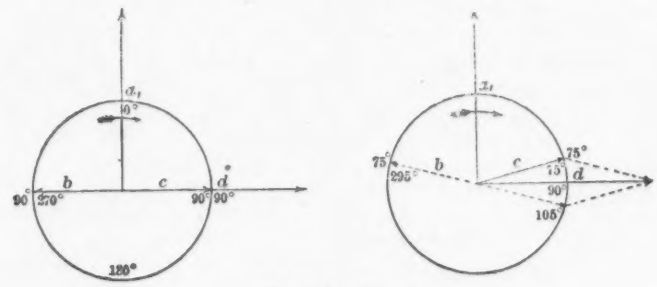
through *n* into *D*, in the direction of the arrow second, as indicated by the curves in Fig. 3; that is, during the rise of the E. M. F. through the machine from the point *o*, to the top of the wave at *p*, the current will flow in parallel into or through the inductance *E* and the capacity *D*, Fig. 2. As soon as the wave of the E. M. F. commences to decline from the point *p*, the condenser will begin to discharge and the current flowing from it will be in the direction of the arrow third, Fig. 2. Also, at the same time, the inductance will discharge its energy by a current in the direction of arrow third, so that the current represented by arrow third will cross the zero line at point *t*, Fig. 3, or is delayed by a time equal to 90 degrees. Thus, we see that the current represented by arrow third will be lagging in its time period considerably behind that in the lead *r*, represented by curve *o-p*. Now, if we wind the lead *l* and the lead *n* upon an iron core as shown in Fig. 4, in opposite directions and of the same number of turns, and have the inductance *E* bear a proper relation to the capacity *D*, so that the currents represented by arrow prime and arrow second shall be equal, no magnetic flux will be produced in the core during the rise of the potential of the machine from *o* to *p* on the curve, but during the fall of the E. M. F. of the machine, and during the discharge of the inductance and condenser which is represented by arrow third, Fig. 2, the currents flowing through *n* and *l* will be in



Figs. 6 and 7.

series and flowing in the same direction; consequently the magnetic flux will be approximately 90 degrees later than it would be if charged directly from the machine. I have represented in Fig. 2 a section of lead by *r*, and it will now be clearly seen that the current in the lead *r* will have a phase difference from the combined or resultant phases in the leads *l* and *n*. Furthermore, a current in the lead *r* will be in lead of the E. M. F. of the machine, because the inductance and the condenser, previously described, cut off the flow of the current before the machine has reached the zero point, and when the lead *r* is placed upon an iron core as shown in Fig. 4 it has a tendency to lag, which counterbalances the lead and leaves the main line current somewhere near in phase with the E. M. F. of the generator.

Refer now to Fig. 4, where the leads *l* and *n* are wound in opposite directions, and completely interlaced upon the iron core *L*, the generator, inductance and capacity being indicated by the same symbols as in previous figures. The lead *r* is here wound upon the second iron core, which constitutes the primary of the simple section of the transformer as shown at *B*, Fig. 1. In reducing to practice and applying the transformer to an induction motor, we find that the inductance *E* can be dispensed with, as the apparent inductance produced by the motor furnishes all the lag necessary; and, it will be noted, that in Fig. 1, the extra inductance which were used in the first experiments, is left out of the combination. The lead from the simple section of the transformer, it will be noted, goes to the centre of the compound section. This diagram does not represent the true con-



Figs. 8 and 9.

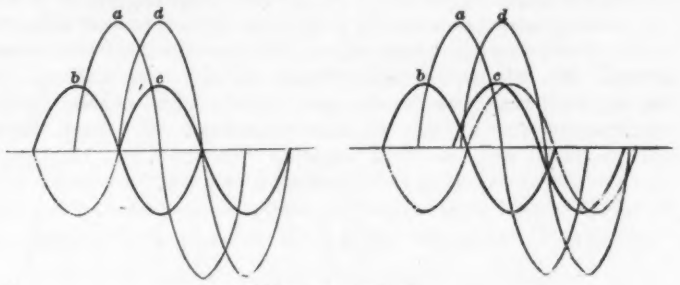
dition of the compound section, for the winding *n* and *l* are together or, as before mentioned, interlaced upon the core. The magnetic flux in the two sections of the transformer are approximately 90 degrees apart. The secondaries are therefore wound each partially upon the two cores, so that the three resultant phases may be produced from two, this being in accordance with Mr. Fred. S. Hunting's invention for changing two phases to three.

Mr. Scott's invention for changing two phases to three may also be used, and is shown in Fig. 5. Making the resultants in this manner by means of the secondary windings contributes also to steadiness of phasing. If desired, two secondaries having a proper two-phase relation may be used on the motor.

E. M. F. curves will be found in Fig. 6, taken from the trans-

*A paper, slightly condensed, read at the September meeting of the American Institute of Electrical Engineers.

former, in connection with a half horse-power motor, running at full load, and Fig. 7 gives the current curves of the same. This motor gives powerful starting torque, and it gives me pleasure to show it to you here in operation. Attention is directed to a feature of the compound coil used in combination with the condenser, which will be found in Figs. 8 and 9. If we suppose a direction of motion as shown by the arrow and the current in the condenser branch leads by 90 degrees, which is represented at *b*, and the current in the inductance branch lags by 90 degrees, as indicated at *c*, and the wires carrying these currents are wound in opposite directions upon the core, we will have a resultant current, which is represented by extension *d*. Increase of load changes the phase relation of the individual branches, but not the resultant secondary, and this is explained by reference to Fig. 9, where a 75-degree lead, and a 75-degree lag are represented by the respective branches, and as the branches are wound in opposite directions, we find that when *b* is turned over, it becomes a lag of 105 degrees, and the resultant of 75 degrees and 105 degrees again produce 90 degrees lag, and the value



FIGS. 10 AND 11.

again represented by the extension *d*, the value of the current is slightly less, but its resultant phase is the same as is represented in Fig. 8. This explains the steadiness of phasing which we are able to obtain. This may be explained by another method of diagraming, as is shown in Figs. 10 and 11, where a curve *a* represents the fundamental current, curve *b*, Fig. 10, a lead of 90 degrees, curve *c* a lag of 90 degrees, and then *b* being turned over, unites with *c* to produce the resultant *d*, which is 90 degrees in lag of fundamental curve *a*. Now, in referring to Fig. 11, where the fundamental current is again represented by *a*, curve *b* represents a lead of 75 degrees, and full line curve *c* represents a lag of 75 degrees; then, when curve *b* is turned over in the windings, as shown in the dotted line, the coils being wound upon the same core, a resultant effect is represented by the curve *d*, which is 90 degrees in phase from fundamental curve *a*. Thus we see by increase of load, which tends to decrease the lead of the condenser circuit, and also decreases the lag of inductance circuit, our resultant is still in the same phase relation to the fundamental current.

The power factor is found to be very good. The current in the main line, feeding the transformer, varying from 10 degrees lead at full load, to 35 degrees lag at no load, and the motor at starting produces the same effect as when working at full load, so that we have very good phasing for starting and full load, as well as a good power factor, it being 82 per cent. even at light loads, and the probability is that may be obtained with very much better results larger sized transformers.

The condenser in this combination fulfills two very important functions—assists first in the phasing, and second, prevents lag upon the line. This arrangement does not prevent idle currents flowing in the motor circuits, and the secondaries of the phasing transformer, and we find in small motors with the high period of 140 cycles that the apparent energy in the motor circuits is sometimes two and one half times the apparent energy in the main line. The capacity of condenser for a one half horse-power motor when 1,000 volts are supplied to the transformer is about 2.4 microfarads. Our condenser for this size, without connections, occupies a space of a cube four inches on each side, and capable of enduring 3,000 volts, or a factor of safety of four, as the voltage on the condenser is about 700. Of course, it will be understood by those familiar with the designs of induction motors, that it is impossible to design a small motor with small power factor, as the air-gap necessary for mechanical construction has to be so large in proportion to the size of the motor.

Many attempts have been made by placing the condenser in direct connection with motors to produce rotary fields, but have so far been attended with little success; as the trade requires the motor to be of comparatively low voltage, which calls for a large capacity in the condenser, and as the output of the condenser of a given capacity is proportional to the square of the voltage, it will be seen how advantageous it is to place the condenser in combination with the primary of the step-down transformer.

Upon reference to the cuts showing the curves obtained of the E. M. F. and current, it will be readily seen that they are all of true sine form. The current for this work was obtained from a 75-kw Slattery alternating machine. This machine has a surface winding on the armature, and, therefore, gives practically a sine wave. Just what the transformer may do on all the various dynamos that are in the market, giving all sorts of complex waves, it is difficult to say, with our present experience, but, so far as we know now, the transformer tends to smooth out all irregularities.

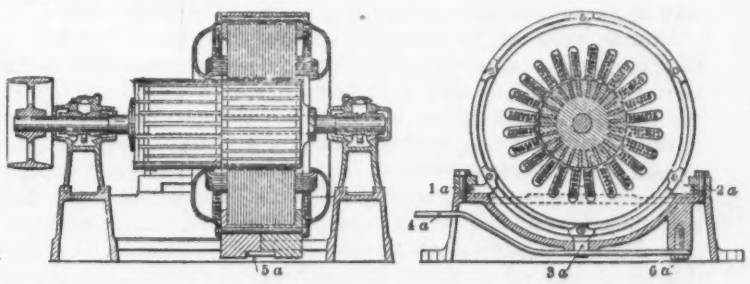
While the principal use for this device at present seems to be the application of polyphase motors to single-phase lighting systems, many new ones undoubtedly will be found. It may seem bold to think of applying this to long-distance trolley railways, but it is hoped to have it done.

It is much more simple to have one trolley wire with track return, than to have two trolley wires, which would be required by the direct application of polyphase systems. A large amount of power requires either a large current or high voltage, in order that the resistance of contact of whatever device is used to make connection to line need not be too great. As viewed at present, it seems as if the alternating current must be used for this work. If so, and unless the traffic is extremely frequent, it will take many more transformers, if they be placed along the line, than if the transformation is made upon the car or locomotive; because the transformers along the line having no trains or cars near them would be idle.

If the voltage is stepped down on the car or locomotive, it is just as economical to do it by the phasing transformer, with the exception of the added weight of condensers, which for a 1,200-hp locomotive will be about two tons, and this is not of consequence on so large a power. These condensers are very compact and efficient, and will stand from three to four times their working voltage, without puncturing the dielectric.

A brief description of the motor may be in order, although it does not belong strictly to this subject. Much difficulty was met in developing a motor for so high a periodicity as 140 cycles. It is necessary to keep the density so low, and it is always such a temptation to try to get all the power from a given piece of apparatus, that they are always heating much more than they should.

With a large number of poles and slots it was found that any use of wide bars in the armature was out of the question, for the eddying currents in the copper were too serious. *We also looked for difficulties which we never found.* At times we thought the heating was due to higher harmonics produced from the phasing transformer; but the fact is, we never found any, unless it was in the experiments upon the two-phase motor. As mentioned before, the waves are all of the true sine form.



FIGS. 12 AND 13.

Cuts of the motor are shown in Figs. 12 and 13, the rotary field being the exterior or stationary part, and the secondary or induced constituting the armature. The armature is composed of two sections, or practically two armatures end to end upon the same shaft, one of the armatures having a low resistance winding and the other a comparatively high resistance; the field is placed over a high resistance for starting, and shifted by means of a lever over the low resistance, when it has nearly attained speed. Of course, this arrangement is for securing the starting up of the motor, and has nothing to do with the phasing transformer, and the motor might have rings for connecting the starting resistance to the armature and operate quite as well. The sliding of the field gave trouble, as the air-gap has to be small, and the play at the sides (noted 1*a* and 2*a*) allowed the armature to strike against the field, and when a tight fit was made, which would work easily when cold, it would

stick fast when the motor rose in temperature; the writer therefore decided to give it quite a clearance at these points, and give it a guide at the bottom of the field shown at 3*a*. This being central and comparatively thin, the expansion is not sufficient to cause sticking, also the guides at 1*a* and 2*a*, being thin vertically, they may fit close and still slide easily. The lever for moving crown back and forth is shown at 4*a*, Fig. 14, and 5*a*, Fig. 13. It fits loosely, having a fulcrum at 6*a*.

DISCUSSION.

Dr. Emery complimented the paper and thanked Mr. Bradley for having presented it. Dr. Duncan asked whether variations in load would have any effect upon the phase differences, and Mr. Bradley replied that they would; the currents, he stated, approached more nearly to a single-phase current as the load lightened.

Mr. Sachs called attention to the similarity between Figs. 1 and 5, and asked for more explicit information as to the difference between the two methods of obtaining three phases from two.

Mr. Bradley explained that the arrangement of the primary connections was identical in both diagrams, the only difference being in the secondaries. Fig. 5 was intended to show Scott's method of changing two phases into three, but this method was confined to the secondary windings, the two phases being obtained from a simple alternating current by means of the author's device in both cases.

Dr. Hutchinson criticised Mr. Bradley's method, and thought that it was only another way of obtaining the same result that Scott's method afforded, and Mr. Bradley stated that so far as the secondary connections were concerned this opinion might be tenable; he called attention to the fact that Scott's method was only suitable for use in connection with a two-phase circuit, while his could be employed upon a simple alternating circuit by the use of the complete arrangement shown in Fig. 1, or upon a two-phase circuit by the use of the secondary arrangement of windings and connections.

Car Heating by Electricity.

In an interesting paper on electric car heaters and heating read at the recent Albany meeting of the New York State Street Railway Association by Mr. J. F. McElroy, the subject is treated in great detail, and interesting data given as to the cost of operation.

Referring to the relative advantage of embedded and exposed conductors, Mr. McElroy says it is evident that the embedding of a resisting conductor in powdered fire-clay or other powdered or pulverulent material, necessarily non-conductors of both heat and electricity, retards the escape of heat. The objectionable result is then reached that the temperature of a conductor rises to such a degree that the conducting material is soon destroyed. On the other hand, if the temperature of exposed conductors is kept low—at, say, 400 degrees Fahrenheit—no difficulty will be experienced from oxidation which at high temperatures would soon destroy it. By using a wire of sufficient radiating surface such a non-oxidizing temperature may be secured, though necessitating a greater length of wire.

Another cause of the destruction of resisting conductors lies in their crystallization at high temperature. This is a difficulty to which German silver or any alloy of different metals is especially liable. For example, German silver is composed of copper, nickel and zinc in equal parts, the zinc having a melting point of 680 degrees Fahrenheit. If, now, this metal is used in electric heaters and its temperature is run above the melting point of zinc, it will be found that crystallization of zinc in the conductor takes place, and in a short time the wire separates and the heater becomes useless. Crystallization of zinc often occurs from jarring or vibrating a wire at a much lower temperature.

It is not necessary, in the construction of electric heaters, to run near to either danger points just mentioned—that of high temperature, or the danger from the use of German silver or other alloys. It is apparent that the temperature above air of the resisting conductor depends upon the amount of heat which that conductor gives out per square foot of its surface, and that the total amount of heat would, therefore, depend upon the number of such units of surface which there may be in the conductor. The reduction of temperature in the resisting conductor may be carried to any extent desired by simply increasing the amount of actual surface in the resisting conductor, its temperature thus being reduced to a point where the conductor is absolutely safe and its life is permanent.

The change of temperature in resisting conductors is attended with a phenomenon, which should be considered in the construction of electric heaters. It is well known that the resistance of a wire of a given material of given length and cross-section depends upon the temperature at which the resistance is measured. Iron wire possesses certain qualities in its variation of resistance with temperature which admirably fits it for use in electric heaters. A coil of iron wire, for example, having a resistance at zero Centigrade of 100 ohms, has its resistance doubled when the temperature is increased to 180 degrees Centigrade and its resistance is increased to 500 ohms when its temperature is 525 degrees Centigrade. The change of resistance in German silver, on the other hand, is but a mere fraction of this amount.

The application of this variable resistance in the construction of an electric heater is the automatic control which this property of iron wire gives over the temperature of the electric heater itself. Two electric heaters, one of iron wire and the other of German silver, both having the same resistance at zero Centigrade, and both being covered with a non-conducting hood which prevents the escape of heat, will, as the temperature rises, act very differently. For example, if the temperature rises to 300 degrees Centigrade only two fifths as much current would pass through the iron resisting wire as passes through the German silver. This throttling action of the iron wire increases more rapidly even than the increase of temperature, so that at 600 degrees about one fifth as much current passes through the iron wire as passes through German silver, and in each case the reduction in current means also a reduction in the amount of heat generated. A heater, therefore, provided with an iron resisting conductor, has this peculiarity over that equipped with German silver, that if for any reason the escape of heat from an electric heater is prevented, either purposely or accidentally, the action of the rise of temperature upon the

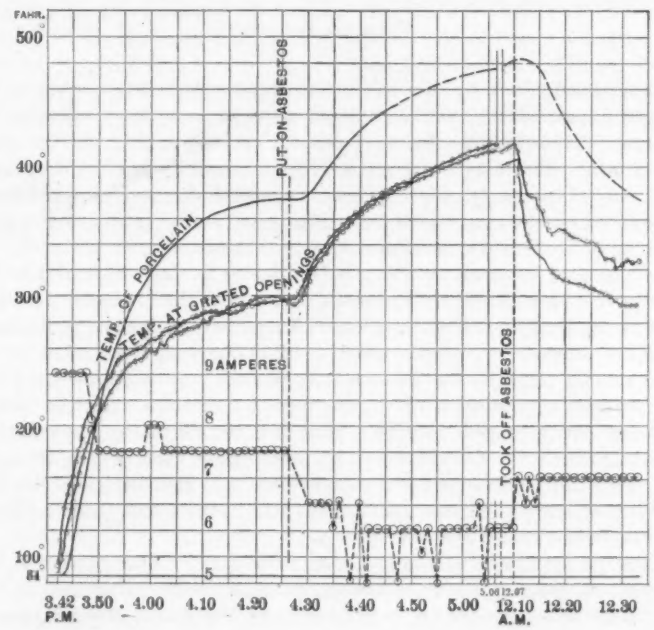


Fig. 1.

heater itself is to throttle down the amount of current passing through it, and hence the amount of heat generated, as to prevent such a high temperature of heat that might prove dangerous. This throttling action of the electric heaters with iron resisting conductors is illustrated in Fig. 1. The upper curve is a curve of temperature obtained from a thermometer placed within the porcelain insulator around which the iron resistance wire is coiled. The two lower curves of temperature were obtained by two thermometers placed within the heater casings and about one half an inch above the coils of the heater proper. The time is laid out on the horizontal line, the vertical lines being lines of temperature. After the heater had been in operation until the temperature within the porcelain and the temperature within the heater casing, as indicated by the two lower lines, had become partially constant, the discharge openings of the heater were covered with a close-fitting sheet of asbestos, which would prevent the escape of heated air. The effect upon the temperature within the heater casing is at once apparent, and the upward movement of the curve indicated the rate and amount of that rise in temperature. The throttling action is illustrated in the fourth curve, which represents the amount of current passing through the heaters and also represents the amount of heat generated. When the circuit is first closed through the heater it will be seen that a large flow of current takes place until the heater itself becomes heated up, when the amount of

current is automatically throttled down. The curve then remains nearly horizontal, indicating a nearly steady flow of electricity, until it reaches the point where the discharge opening of the heater was closed, when the current drops, the amount of this drop indicating the amount of the throttling action of the conductor itself. At the point indicated in these curves, the asbestos damper was removed from the discharge of the heater, and the curves then indicate the fall in the temperature of the space above the heater, while the curve showing the amperes rises in a very short time to its normal height, indicating that when the heat is free to discharge from the heater more heat is generated. This action will take place in any heater in a car, and will take place in one heater independent of others.

Fig. 2 was made from tests in which the temperature at the grated openings has been taken very carefully with thermometers placed against the grated openings but not within the heater case. This would indicate the temperature in front of the heater openings and at points where the clothing of the passengers might possibly touch, and shows that the highest temperature in the air that is reached is about 180 degrees F., due to the free discharge of air up through the heater by which the heat as fast as it is generated is carried into the car. Another curve shows the temperature recorded by thermometers placed within the heater case and within one half inch above the wire coils. The upper curve indicates the curve of temperature

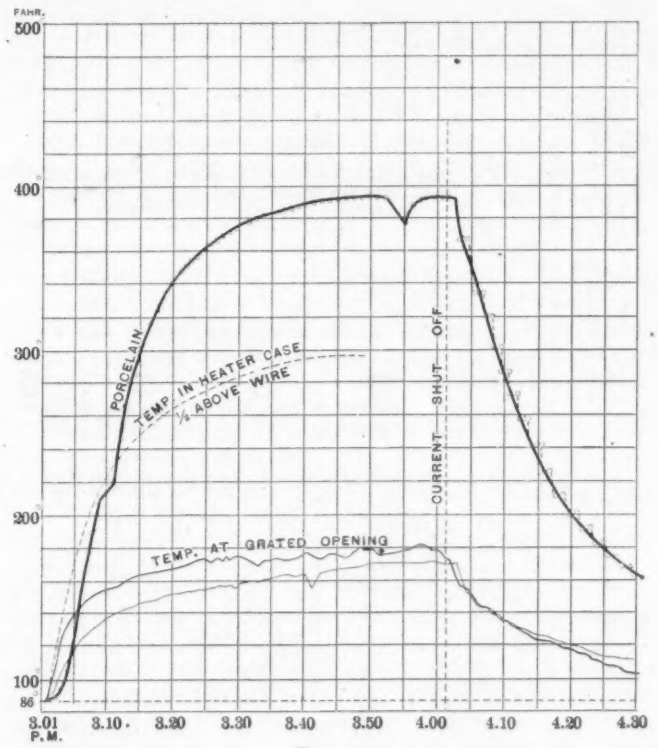


FIG. 2.

of the porcelain itself and was obtained from the readings of the thermometer placed within the hollow openings of the porcelain. It is seen that the temperature of the porcelain rises rapidly and the temperature also descends rapidly when the circuit is open.

It is an easy matter to determine the exact amount of heat which is produced in electric heaters when the consumption of current is known. For example, if we find the number of watts by multiplying the number of amperes passing through the heater by the difference of potential at the heater terminals, and then divide the number of watts by 1,047, we will have as quotient the number of British thermal units of heat generated in the electric heater per second. If we consider the electric heaters in a car to be using as a maximum 12 amperes of current on a 500-volt circuit, we will find that 12 amperes of current multiplied by 500 will give us 6,000 watts. Dividing 6,000 watts by 1,047 we obtain 5.73 British thermal units of heat generated in the car per second. Multiplying 5.73 British thermal units by 60 will give us 343.8 British thermal units per minute. The quantities of heat necessary for car warming at temperatures of 50, 37½, 25, 12½ and 0 degrees F. are, respectively, 4,000, 8,000, 12,000, 16,000 and 20,000 B. T. U. per hour. The average requirements during the months of Winter when heat is used are, approximately, 10,000 B. T. U. per hour.

The amount of heat required, however, differs somewhat according to the construction of cars, to their exposure to winds on the lines where they are run and to the care exercised by conductors in closing the doors promptly when passengers enter or leave the cars. All of these are points which affect materially the temperature which will be maintained in a car with a fixed amount of heat. Also the number of people in a car affects quite perceptibly the amount of heat required. Crowded cars require less heat to maintain a given temperature than is the case with cars carrying but few passengers, due to the amount of heat given off from the bodies of passengers. Experiments have been made as to the effect of passengers upon the temperatures of cars and houses. It has been found that each person gives out 191 British thermal units of heat per hour. When we compare this amount with the average amount of heat required during the cold weather, we find that the heat given out by 52 persons will maintain the same temperature in the car as it is required on the average during the Winter months. This point has a practical bearing in the heating of cars, for the reason that if a car is heated uniformly, as with a stove, it would be found over-heated during those hours of the day when the cars are filled with passengers. When electric heaters are used some roads have established the practice of reducing the heat between certain hours when their cars are filled with passengers. This would still allow a comfortable degree of heat to be maintained in cars, and at the same time would allow the use of the extra power for propelling cars at the time when travel is the heaviest. The next point in regard to electric heating is the regulation of temperature. As the temperature of the outside air during the heating season will vary from 50 degrees to 15 below zero, it is important that the electric heating apparatus be so constructed that the amount of heat given to the car varies so as to meet the demands of the variable weather. This is necessary for two reasons. First, it is necessary in order to maintain a comfortable temperature in the cars with variable conditions in the weather, and second, it is important in order that the consumption of current shall be adjusted to the actual demands. Undoubtedly a great saving in the use of current is brought about by the use of apparatus that is provided with means for proper regulation.

A device introduced for the purpose of regulating the temperature of cars, and by which five different intensities of heat may be obtained, corresponding to consumptions of current varying from two and one quarter to 12 amperes, operates by shifting the heating coils constituting the car equipment, into series and multiple series, so as to vary their combined resistance and hence to vary the flow of current through them. On small cars and in climates where a comparatively small amount of heat is required, an equipment consisting of four heaters is often used instead of six, as in a standard equipment. These four heaters are connected up with a three-point switch which is so arranged as to place the heating coils in multiple series to vary the consumption of current from two and three quarter up to eight amperes.

As to the cost of heating cars by electricity, it is evident that the cost is determined by the cost and quantity of current consumed. If the number of ampere-hours on a 500-volt circuit can be once determined and the cost of an ampere-hour on the same circuit is known, the cost of running electric heaters can be readily ascertained. The question of cost, however, is not easily determined, as it still remains an open question as to just what items should be charged to electric heating. It would be but fair for a company considering the advisability of introducing electric heaters in its cars to consider, not the total proportionate cost of current consumed, but rather the additional cost of generating the current to supply the electric heaters—not charging to electric heaters such power-house expenses as would continue the same provided electric heaters were not introduced, but only the cost of the additional current. These costs have been carefully determined, based upon the cost of producing power by different types of engines as contained in a paper by Dr. Charles E. Emery, in the Transactions of the American Institute of Electric Engineers for March, 1893. The costs are based upon units of 500 hp and, so far as the figures by Mr. Emery are concerned, give the cost of horse-power at the engine wheel or jack shaft. Efficiencies here are allowed of 90 per cent. in the generators and 93 per cent. in the distributing system, making a combined efficiency of generators and lines of about 82 per cent. Corrections can be made upon the figures contained in the table to fit any given case, as it is found that the efficiency of the lines may be greater or less than 93 per cent.

It will be seen from the accompanying table that the cost of operating electric heaters will depend upon the kind of engine employed and the cost of coal. For example, if coal costs $2 a ton

of 2,000 pounds, and if the average consumption of current in cold weather is seven amperes, and if a compound low-speed condensing engine is taken as the average type of engine in point of economy in consumption of fuel, it will be seen that seven amperes for one hour will cost 1.17 cents.

From the reports received, the average length of time a car is in service per day in the Winter time is shown to be 15 hours. The cost of operating electric heaters with the average consumption of current in cold weather would therefore be 15 times 1.17 cents, which equals 17.55 cents for 15 hours. This cost does not allow for any depreciation in heaters, as the three years of service of the heaters here considered does not appear to have any effect upon the life of the conductors, and not a single coil in any heater has ever been renewed in this length of time. So far as examinations of the coils that have seen three years of service can determine, absolutely no oxidation has been produced upon the wires. Some allowance, however, should be made for repairs, when the amount of necessary repairs can be ascertained.

As to the cost of heating by stoves, a number of reports have been received from different railways in New York State using stoves. The list of questions submitted was designed to bring out as full information as possible in regard to the operation of cars equipped with these stoves. Several roads furnished reports, and where quantities are mentioned the figures given above are the average of the quantities stated in these reports.

Table Showing Fuel and Other Costs of Electric Current on a 500-volt Circuit, and the Fuel Cost of Operating an Electric Heater in Five Different Positions of a Temperature Regulating Switch.

Type of Engine.	I. H. P. to produce 500 net H. P. at engine or jack shaft.	Steam pressure, gauge.	Pounds of coal per I. H. P. per hour.	Total cost in cents of one ampere-hour on 500-volt circuit delivered at the car, including operating expenses and coal, supplies, repairs, wages, insurance, taxes, renewals and 8 per cent interest on the investment.	Cost of coal per hour in cents for heating a car with an equipment of six electric heaters on a 500-volt circuit, the switch being placed in different positions, as follows:				
					Intensity 1 Uses 2.14 Amperes.	Intensity 2 Uses 2.88 Amperes.	Intensity 3 Uses 6.98 Amperes.	Intensity 4 Uses 8.09 Amperes.	Intensity 5 Uses 12.05 Amperes.
				Coal at $2.00 per 2240 lbs.	Coal at $2.00 per 2240 lbs.	Coal at $2.00 per 2240 lbs.	Coal at $2.00 per 2240 lbs.	Coal at $2.00 per 2240 lbs.	Coal at $2.00 per 2240 lbs.
Simple high-speed non-condensing	542	100–120	3.882	.84	.64	.86	2.01	2.43	3 62
Simple low-speed non-condensing	556	100–120	3.412	.78	.57	.78	1.89	2.19	3.26
Compound high-speed non-condensing	542	100–120	3.059	.74	.50	.68	1.64	1.91	2.85
Triple-compound high-speed non-condensing	542	150–170	2.824	.72	.47	.63	1.52	1.77	2.63
Simple high-speed condensing	542	100–120	2.588	.68	.43	.58	1.40	1.62	2.41
Simple low-speed condensing	556	100–120	2.353	.64	.40	.54	1.30	1.51	2.24
Compound high-speed condensing	542	100–120	2.353	.66	.39	.52	1.27	1.47	2.20
Compound low-speed condensing	556	110–125	2.118	.62	.36	.48	1.17	1.36	2.03
Triple-compound high-speed condensing	542	150–170	2.000	.62	.33	.44	1.08	1.25	1.86
Triple-compound low-speed condensing	556	150–170	1.882	.60	.32	.43	1.04	1.21	1.80
Triple-compound low-speed condensing	556	160–170	1.765	.59	.30	.40	.98	1.13	1.69
Ditto for probable maximum results	556	160–170	1.474	.59	.25	.33	.81	.94	1.40

Note.—The heater is usually operated at intensity 3, which meets the requirements of outside temperatures between 20 and 30 degrees F.

Taking the average made in the answers referred to, it was found that 33 pounds of coal were used per car per day, costing $4.55 per ton of 2,000 pounds. This coal costs 7½ cents per day. The average cost of repairs per car is ½ cent per day. The average cost of dumping fires, removing coal and ashes before a car is run out of barn, and coaling up and kindling fire in the morning, including the cost of kindling used and that part of cleaning cars chargeable to stoves, is 10 cents per day. The average cost per day of other expenses chargeable to stoves not included in above, such as cost of removing stoves for the Summer, installing of the stove in the Fall, repairing of head linings, repainting, etc., averages 1¼ cents per day. Without adding anything to the cost of the stove for the space for one person occupied by the stove, the total of the items so far aggregate 19¼ cents per car per day. It has already been stated that the extra cost of current based upon the cost of power necessary to heat a car with seven amperes of current on a 500-volt circuit aggregates 17.55 cents per car per day. This amount will be modified as different types of engines are used; for the type of engine generally used it is correct. Other questions of greater importance enter, however, than the cost of the mere heating by electricity or stoves, such as the effect which electric heating has in inducing travel upon street car lines. It is, however, a difficult thing to determine in figures exactly what increase of travel takes place, on account of having cars properly heated at all times, and that heat being properly distributed through the car. This point is worthy of the consideration of managers of street railways in the matter of securing patronage for their lines.

Electric Locomotives for the Huron Tunnel.

It is stated that the management of the Grand Trunk Railway is figuring on an adoption of electric locomotives to haul its passenger trains through the tunnel under the Detroit River at Port Huron; the locomotives to be similar to those in the Baltimore & Ohio tunnel under Baltimore. A desire to avoid smoke and cinders was among the causes which induced the Baltimore & Ohio Company to install electricity. The Grand Trunk is forced to abandon steam engines, so it is said, because of their effect upon the tunnel structure. The latter, cut through the rock, is lined with steel casing, back of which is a filling of what is said to be a peculiar kind of asphalt. The tunnel is a mile and one eighth in length, and the grade at both ends is an important one, amounting to 105 feet in the mile. Specially constructed locomotives, weighing 95 tons, and having eight drivers, are used to haul trains through. In developing the energy needed to handle long, heavy trains, it has been found, it is stated, that the excessive heat and escaping steam from the engines is exercising a deteriorating effect upon the asphalt backing, and it is said that steam has been found to exercise a serious influence upon other portions of the tunnel structure.

Pole Tax Legal in McKeesport.

In the case of the city of McKeesport, Pa., against the Citizens' Passenger Railway Company, Judge White has filed an opinion holding that the city ordinance imposing a $1 tax on each pole for railway or other wires is legal.

Invention of the Electromagnetic Telegraph—VI.

BY EDWARD LIND MORSE.

In my review of the interesting series of papers on the invention of the electromagnetic telegraph, I shall confine myself to a consideration of the value of the testimony adduced against Morse's claims.

Herr Rudolph Petsch says in the beginning of his article that the birthplace of the telegraph is really to be found in the old world. Further on he says that he agrees with Dr. Dub in saying that "undoubtedly the credit of the invention belongs to the expert who builds an apparatus whose practical application is plainly visible, and not to him who, without any scientific reason, makes a vague intimation in an uncertain manner."

I agree with Herr Petsch in his latter statement, and therefore not in his first.

Of course, the valuable experiments of which he tells us were not all "vague intimations without any scientific reasons," but it was Morse who "built an apparatus whose practical application is plainly visible." The proof of this is that Morse's method survives, while all the others, except Cooke and Wheatstone's, are relegated to the mouldering list of unsuccessful attempts.

The incomprehensible reason why Steinheil's telegraph did not come into further use, was that Steinheil, after seeing Morse's instrument, shook the American warmly by the hand and said that Morse's invention was much superior to his own. Steinheil further strongly urged the Bavarian government to adopt the Morse system.

Herr Petsch refers to Jackson's claims. All who are versed in the history of the telegraph knows that these were exploded long ago. Further on he says that Morse's first idea for rendering the characters permanent was to be accomplished electro-chemically, or by burning groups of holes in the paper. This is not quite exact. As will be seen from the 1832 sketches reproduced in Mr. Pope's article, this was but one of two methods. The other was essentially the telegraph of to-day, namely, an electromagnet, a lever with recording pencil at one end, and armature to receive the action of the magnet, and a system of dots and dashes—not the alphabet of to-day, but the first suggestion of that alphabet.

Herr Petsch credits Wheatstone with the invention of the relay, but Wheatstone's countryman, Mr. Fahie, credits Morse with its independent invention at probably an earlier date than Wheatstone's. Mr. Fahie, at the beginning of his article, refers to a circular issued by Hon. Levi Woodbury, and speaks of an article by Sidney E. Morse in the New York *Observer* as S. F. B. Morse's answer to that. By reference to Prime's "Life of Morse," page 297, it will be seen that S. F. B. Morse explicitly says that this was a description of S. E. Morse's idea, not his own. Answers to the circular were to be sent by Oct. 1, and Morse sent his on Sept. 27, naturally taking advantage of the time allowed. See also Mr. Jones's article.

The discrepancy in the two extracts from letters to Jackson is not very clear. Morse's words are, "to devise another mode of applying my apparatus." That is, to abandon the idea of marking chemically in favor of the other contemporary idea of marking by the lever. The word "device" is perhaps not the one which would best describe what Morse meant, but the meaning, in view of the acknowledged facts, is clear.

Mr. Fahie thinks that Morse antedates his experiments with modifications of the marking apparatus. He thinks that the dates should have been 1838 to 1848 instead of 1836-37. Yet Prof. Gale says the same thing as Morse. In Prime's "Life," page 301, Gale says, "The labors of Prof. Morse at this period [early part of 1837] were mostly directed to modifications of his instruments for marking," etc.

Mr. Fahie and Mr. Jones both credit a certain Mr. Thomas Avery with the invention of the finger key nearly in its present form. In an "Historical Sketch of the Electric Telegraph," by Alexander Jones, published in 1852, the same claim is made for Avery. This is what Morse has to say in a marginal note: "This key among others was made by Messrs. Fry & ———, of New York, for me some two or three months before Avery was known to me or in my employment, and their bill and receipt is on file in the Treasury Department. Avery made a key which was discarded as useless." And on the fly-leaf of the book appears a sketch, shown in Fig. 1, and the following note in Morse's handwriting, "Avery's key, rejected by me in 1844. The one adopted by me was one of the keys of the correspondent made by Fry, in New York, and afterward modified by Mr. Vail, drawn out and made at Speedwell. It is the present mode of a lever and spring under it instead of a spring lever, as in mine. Avery has perjured himself in this matter."

Other statements made by Avery Morse characterizes as false or distorted. This would agree with Vail's statement in Mr. Pope's article.

Mr. Fahie takes exception to the way in which Morse always spoke of his invention. That errors in dates sometimes did occur seems to be true, but not to the extent claimed by Mr. Fahie or Mr. Pope, as I shall show. We must not forget that the data at that time were not so voluminous nor so easily accessible as they are at the present time. That Morse consciously swore to what was not true nobody who knew the man will believe. That he sometimes made mistakes is more than possible, but as our ex-minister to England, Mr. Phelps, once said: "Who never makes mistakes, never makes anything." That he was jealous of his rights was natural, for he was made the target for the slings and arrows of unsuccessful and dishonest men, who strove to wrest from him some of his hard-earned honors. He bore the brunt of all the battles; he was singled out for all attacks. He was involved in litigation and newspaper controversy to an extent well nigh incredible. In going over his private papers and documents, reading the volumes of newspaper cuttings, the pamphlets of all sorts and descriptions, I wonder, not that he made mistakes, but that he made so few.

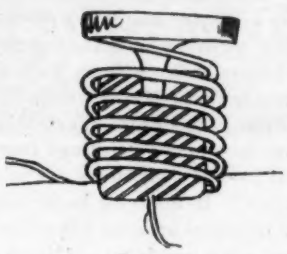


FIG. 1.

Mr. Fahie follows out Morse's simile of his telegraph being his child, in a clever and amusing way. But granting all he says, so much the more credit to Morse that his prematurely born bantling grew up to such a sturdy manhood. And, after all, whose was the child—the doctor's, the druggist's, the nurse's or the parent's?

I have left a consideration of Mr. Pope's article until the last, for his claim for Alfred Vail of the invention of the Morse alphabet is the most serious one of all.

Before proceeding to take up that point I shall touch upon one or two other things in his article.

I have no wish to belittle the important discoveries of Prof. Henry, but he did not invent the telegraph. "The reduction to practice" is missing. He himself has said that he had no intention of making a practical use of his discoveries. These undoubtedly made the telegraph possible, but so did the discoveries of other scientists. Henry's place is with Volta, Arago and Ampère; Morse's with Watt, Stephenson and Fulton.

Mr. Pope thinks that some error has arisen in assigning 1835-36 as the date of the first reduction to practice of Morse's device, because Morse, in his letter to the Secretary of the Treasury, Sept. 27, 1837, says: "I was not able to test the whole plan until within a few weeks." This seems to be a quibble of words. Not able to test the whole plan does not necessarily mean that Morse did not test his plan in a more or less imperfect form. The testimony of Prof. Gale, Mr. Rankin, Rev. Mr. Tappan, Daniel Huntington, Hon. Hamilton Fish and others is of too solid a character to be lightly brushed aside. They could not all have been mistaken or all have borne false witness, yet they all declare that they saw a machine which did work, however imperfectly, in 1835 and 1836. (See Prime's "Life," pages 298 to 311.) In Mr. Pope's list of what claims Morse was entitled to make in 1837 he seems to have forgotten the relay.

As to the apparent conflict of testimony about the four-pointed pen, the probability is that several were made, some four-pointed, some three, for it is on record that the number of points was reduced from four to one.

Mr. Pope himself says that F. O. J. Smith's uncorroborated statements are of no value. I shall not comment on the extracts from Smith's letter, further than to say that when it was written Morse was unconscious and died three days later. A short while before his death a publication made in Hartford, and evidently inspired, if not written, by Smith, was brought to Morse's attention. Among other statements in this publication was one crediting Vail with the invention of all the improvements in the telegraph after his partnership with Morse. Marginal notes in Morse's handwriting characterize this claim as "false." In one of the last letters which Morse ever wrote he speaks of this publication and says that when he gets well he will answer it. He died a few weeks later.

My own idea is that it was this same F. O. J. Smith who first started the fable that Vail invented the dot-and-dash alphabet. I presume that the error arose from the fact that Vail invented a

device for printing the Roman alphabet by electricity. It was this alphabet, not Morse's, that he invented!

The strongest proof that Vail did not invent the telegraph alphabet is given by Mr. Pope. In a letter from Alfred Vail to Mr. Kendall, dated Oct. 7, 1852, Vail says, "Even some portions of the telegraph which I invented have never been accorded to me, viz. *the mode of recording by the indentation of paper under a grooved roller.*" This exhausts his claims. No mention is made of the alphabet, and nowhere in any of Vail's letters or in his diary does he claim the alphabet. In the very peppery letter of Vail's which follows, he is most anxious to assert his claim to this quite unessential invention of the dry point. He says that he "never refrained from stating it anywhere." Where is the great modesty which we are told prevented him from claiming the alphabet? In his book he is very careful to mention everything which he invented or even improved. (See pages 24, 43, 45 and 59.) If he had even improved on Morse's original conception, we may be sure he would not have hidden his light under a bushel.

All the patents were taken out over Morse's name alone with the full consent of Vail, so that Mr. Pope's exception in the matter of the dry point is not particularly well taken. But if Vail did really invent so much of the telegraphic apparatus as is claimed for him, why did he not assert his rights? The peaceful unity of the invention could have been preserved under the joint names of Morse and Vail, and Morse was in no position in those days to dictate to or overawe anybody. Moreover, as Mr. Pope shows, Morse was so scrupulously honest in his dealings that he made an enemy of F. O. J. Smith. The question of character plays some part in these proceedings, and in all business relations Morse is admitted to have been most sensitive and honorable. It is not credible that such a man would have stolen honors due his partner, nor is it credible that such a man as Vail shows himself to be in his letters would have tamely submitted to the robbery.

Mr. Reid, in his valuable communication which forms part of this contribution, will dispose of Baxter's testimony. The article of Moses S. Beach was published Sept. 25, 1858. On July 24, 1858, Morse sailed for Europe with his family. He remained there until Nov. 17, when he went to Porto Rico, and did not return to New York until the middle of April, 1859. The dissemination of news was not so rapid and thorough in those days as it is now, and the probability is strong that Morse never saw or heard of that article. If he had seen it he would have answered it; he never shirked his part in any controversy, but was ever ready to dip his pen into ink and write replies to attacks made upon him.

It has been said that the claims made for Vail have remained unanswered by his family. Taylor's 1879 reprint of the Smithsonian Report of 1878 was only brought to our attention within the last two years. When Mr. Pope's *Century* article appeared I was in Europe, studying painting, and did not return to America until five years later. Others of my family were also abroad. My father's papers were locked up in a chest in the old home at Poughkeepsie, and not accessible. Mr. Jas. D. Reid had intended to write an answer for us, but the pressure of other duties prevented him.

To the various newspaper squibs answers were sometimes sent, but they were in general ignored, on the advice of old friends. I for my part, did not wish to rush into print until I had time to examine my father's papers and gain some mastery of the subject. It is only within the last six months that I have been able to do this. I am glad of the opportunity which the present series of papers presents, of showing that Morse's family are not unwilling or unable to answer attacks on his fame and good name.

As a curious instance of efforts at antedating and of misstatement which appear on the other side of the Morse-Vail controversy, I quote from Mr. Taylor's pamphlet, mentioned above. On page 85 we find:

"In a biographical sketch of Alfred Vail by Mr. Frederick Brent Read, of Cincinnati, published in 1873, the writer states without qualification: 'Alfred Vail first produced in the new instrument the first available *Morse* machine. He invented the first combination of the horizontal lever motion to actuate a pen or pencil or style, and the entirely new telegraphic alphabet of dots, spaces and marks, which it necessitated; *and he did so prior to September, 1837*, the month when the old instrument passed into his hands for reconstruction . . . The new machine was Vail's not Morse's.'"

This is gravely put forward as an argument against Morse, when the veriest ignoramus who has ever glanced at the history of the telegraph knows that Vail never heard of the telegraph before September, 1837, and that the first combination of the horizontal lever motion was invented by Morse on the *Sully* in 1832.

In 1869 an uncle of Alfred Vail's wrote an article to the *Hours at Home* in which he hints that his nephew invented the Morse alphabet. I have a pencil memorandum in Morse's well-known handwriting which says: "See page 30 (Vail's book) for a complete refutation of the hint in *Hours at Home* that Mr. Vail invented the Morse alphabet, so called."

The reason why Morse never troubled himself much about the claims made, not by, but for Alfred Vail, is clear enough. He thought it unnecessary to substantiate his own claim to something which Vail explicitly allowed, and if there is very little written evidence in relation to the alphabet it is because its parentage was not seriously called into question until after Morse's death.

The article from Mr. James D. Reid, which will follow, was courteously sent to me by him when I recently asked for his recollections as to the parentage of the telegraph.

(*To be continued.*)

Prof. Forbes Castigated.

An editorial in the London *Engineer* comments in sarcastic terms on a recent article by Prof. George Forbes in *Blackwood's Magazine*, on the Niagara plant, the opening sentences being as follows: "Who has harnessed Niagara? Prof. George Forbes. Who says so? Prof. George Forbes, in the September number of *Blackwood's Magazine*." The *Engineer* then proceeds to say that a group of engineers, "including some of the greatest men in England, the United States and also Italy and other out of the way places," are understood in England to have planned and carried out the work of completion. It now learns, however, that it remained for Prof. Forbes to put the coping stone, or pinnacle, so to speak, on the structure they had reared. Referring to a remark of Prof. Forbes' in the same article, that "the world makes two grand mistakes, one of which is that Americans are original inventors and the other that they have a sense of humor," the *Engineer* intimates that if the Americans had been able to see the humor in such an action they would not have sent for Prof. Forbes. The editorial ridicules in general the personal claims of Prof. Forbes and his severe strictures on everything American, and pronounces the *Blackwood* sketch a unique example of professional advertisement.

The *Blackwood* article also furnishes occasion to the New York *Times* to pay its respects to Prof. Forbes. In an editorial it points out that not one of the papers containing an official account of the Niagara enterprise so much as refers to Prof. Forbes as the sole author and finisher of the great work, and after quoting the actual acknowledgment of his services from official sources, continues as follows:

"Prof. Forbes, however, is a man who knows his value, and he has no notion of being damned with such disgustingly faint praise as this. He proceeds to supplement it as follows: 'The letter from which I have made this extract attributes the splendid results which we attained to engineering skill. I am inclined to believe that they were fully as much the result of an exercise of tact, judgment, and forbearance, combined with firmness—qualities which I do not hesitate to say that both the officers of the company and myself recognized in each other.' But it is quite plain that his admission of equality is a mere polite fiction, for in other places he says: 'I had at times great difficulty in keeping the president and vice-president in hand. . . . On such occasions I would write to my millionaires and tell them that if they did not do what I told them they would be personally answerable to the directors and shareholders for any disaster that might occur.' Thus did the gentle Forbes go on exhibiting tact, judgment, and forbearance, combined with firmness, and getting himself beloved, and this present paper is a perfect pyrotechnical display of those qualities. 'It is by no means an everyday occurrence,' he observes, 'for financial men in a great country like the United States to invite a foreigner to carry out one of the greatest works of modern times in any country.' He explains this with his unfailing tact, judgment, and forbearance, combined with firmness. 'There are two great mistakes commonly made as to Americans. One is that they are original inventors; the other is that they are humorous. Neither proposition is true,' as Prof. Forbes goes on to show in detail, and he shows many things more, in addition to vindicating himself as the real author of the utilization of Niagara, and almost as the discoverer of America, for he writes about the country as if it had never been visited and described before.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

Experimental Study of a Small Dynamo.—"L'Eclairage Elec.," Sept. 7, contains a long article by Mr. Hanappe in which he gives the results of a detailed examination of a very small dynamo of 20 to 35 watts when run as a dynamo and as a motor, with constant voltage or with constant current. It was a machine of the Manchester type, well proportioned and constructed; the chief object was to determine the curves of the variations of the values of different elements and to find between what limits the efficiencies varied; the results are given in tables and numerous curves. As a motor the efficiency of transformation was 35 to 55 per cent., the electric efficiency at about 4,000 revolutions was 60 to 70 per cent. and the total efficiency 24 to 33 per cent.; by doubling the cross-section of the wire of the magnet, there would be a gain of about 10 per cent. in the electric efficiency; as a dynamo the total efficiency was 12 to 28 per cent., but by doubling the cross-section of the wire of the magnets an efficiency of 25 to 42 per cent. would be obtained. In conclusion he gives briefly some similar results for a motor of 60 to 75 watts for which the efficiencies were about the same.

Graphical Theory for the Calculation of Multiphase Induction Motors.—A German translation of a paper from the Swedish by Mr. Danielson is published in the "Elek. Zeit.," Sept. 12; the method which he uses is similar to that used by Kapp in his transformer diagrams.

High-Potential Dynamo for Laboratory Practice.—A translation of the article which was abstracted in the Digest, Aug. 3, is published with the illustrations in the "West. Elec.," Sept. 21.

LIGHTS AND LIGHTING.

Alternating-Current Arc.—Prof. Blondel, in a communication to the "Elek. Zeit.," Sept. 12, comments very favorably on the article by Mr. Goerges (see Digest last week), and gives his views on some of the points brought out in the discussion. He refers to the paper which he read at the Chicago Congress (see page 279 of the proceedings of that Congress), in which he showed about 100 curves taken by a rapid process requiring but two to three minutes for a set of curves; in this he used sine curve E. M. Fs.; his curves showed some quite unexpected results, and point out very clearly the effects of the conductivity of the gases and of the core of the carbon; that such gases conduct was shown more than 10 years ago by Prof. Blondlot, who showed that polarization is impossible, a result which does not agree with that of Dr. Pringsheim (see Digest last week); owing to this conductivity the current may flow continuously, although the arc itself is really interrupted twice in every period. Regarding phase shifting, his results showed that in general it did not exist, and he concludes that the expression "apparent phase shifting" is confusing and should be abandoned, the term "power factor" being the only proper expression to use; the values found by him for this factor agreed with the results of Heubach, but not so well with those of Ayrton and Sumpner. He states that the best wattmeter can be unsuitable for such measurements when the E. M. F. curve approaches that of the rectangular type, because with the higher harmonics the reactance of the movable coil becomes much greater than with the usual frequency. The curves of Goerges do not show any shifting if one remembers that the lamp has a regulating coil; in some of Blondel's curves a phase-shifting was plainly indicated (see Digest, Sept. 7), but he does not believe that it is generally the case. He adds that in practice arc lights are usually supplied from transformers and the E. M. F. curve would therefore be quite different from that of the alternator, but in most cases it is not very different from that of a sine curve. He states that further researches should be made with the alternating-current arc and suggests that the use of his lumenmeter (see Digest, June 29 and July 20,) might facilitate the measurements; he intends soon to publish results of such a test.

The Electric Arc.—The Lond. "Elec.," Sept. 13, contains another installment of the serial by Mrs. Ayrton. It contains the tabular data which were used in plotting some of the curves. She then gives a good abstract of the work done and deductions drawn by others who experimented in this field, beginning with the experiments of Edlund in 1867.

Train Lighting.—"Zeit .f. Beleucht.," Sept. 15, reprints the first portion of a paper by Mr. Staberow in which he describes the system used on the Dortmund Railway since 1893, including illustrations of the car and the accumulator holders. In this installation each car is provided with a battery of accumulators to run the lights on that car; the voltage of the lamps is 15, thus requiring eight cells to a car; these are supported below the car body and are easily changed; the total weight, including the receptacle for holding them, is 616 pounds; there is a single meter reading in hours, by means of which it is always possible to readily see how much energy there is still left in the cells; Tudor accumulators are used and their capacity is such that during the darkest Winter day they need be charged only once a day; the capacity is about 90 ampere-hours and the current required for one car is 6.2 amperes, from which it follows that one charge will run the car 14 hours; the cells are filled partly with liquid and partly with a gelatinous electrolyte, but it has been found more satisfactory to dispense with the gelatine and use the liquid only; the article is to be concluded and the cost of operation is to be given.

POWER AND HEAT.

Heating of an Electrode in an Electrolyte.—The short paper, by Mr. Gosselin, which was abstracted in the Digest, Sept. 7, is published in full in the "Bul. Soc. Int. des Elec." for July.

Annealing Armor Plates by Electricity.—A description of the process used for annealing Harveyized plates (see Digest, March 16), is reprinted from the "Pacific Electrician," with the illustrations, in the "West. Elec.," Sept. 28.

Welding and Soldering.—A translation of the article abstracted in the Digest, Sept. 21, describing the Zerener process, is published in the "West. Elec.," Sept. 28.

Power for Manufacturing Purposes.—An abstract of a recent paper by Messrs. Stone & Webster is published in "Elec. Eng.," Sept. 25. They show the amount of power lost in the transmission machinery of an ordinary stamping mill; it was found to be 60 per cent., the total power generated being 62 hp; they show that most of this loss could be saved by the use of electric transmission. They state that in the following five well-defined cases, electric transmission can always be used to advantage. Where a large water-power is available at a considerable distance from a mill which is in need of more power; where, in large mills, it is desired to transmit power farther than can be done by belting; where small water-power privileges are available at various points along a stream all of which are to be concentrated at one point; where the best site for the mill is some distance from the source of water-power; and when for special reasons it is important to do away with shafting throughout the mill. Several estimates of plants are given, one for 1,000 hp at a distance of two miles; assuming $12 per year for the total cost of the power delivered to the dynamos and a transmission efficiency of 80 per cent., the cost of electrical machinery will be about $23,000 and the poles, wire and accessories, $13,000; these figures, they say, practice has demonstrated to be substantially correct; the cost of power delivered amounts to $6.30 for a 10-hour run or $8 for a 24-hour run to which must be added $15 for the cost of the power, making a total of $21.30 and $23, respectively, which is evidently less than the cost of steam power would be except under extremely favorable conditions. Another estimate is given for a case in which the mill buildings are separated 1,000 feet, one mill requiring 500 and the other 100 hp; the ordinary practice would be to install separate steam plants, but by generating all the power at one point the saving will more than pay for the interest, depreciation and maintenance of the electric plant; they find that the interest, depreciation and maintenance could be as much as $1,600 for delivering 100 hp, but their figures show that it would be only $800, showing a saving of $800. They describe a plant erected at Shirley, Mass., in which a small water-power was added to that already used by the mill; a 500-volt, 50-hp dynamo was installed and arranged so that it could be regulated and controlled from the motor end; it was also provided with an artificial load to prevent racing; the cost was less than $15 per hp, while that of a steam-power plant would have been about $40.

Water-Power Installation at the Great Falls of the Potomac.—The "Eng. News," Sept. 12, contains a description of the proposed plant to utilize the great falls of the Potomac, which is about 15 miles above the city of Washington, D. C., and transmit the energy to Baltimore and Washington. The description is limited chiefly to the civil engineering features and includes a map of the district. It is estimated that 10,000 hp can be developed with very little chance of interruption, but the works will be constructed for 35,000 hp which can be relied upon for nine months in the year, an auxiliary steam plant being added to make up the deficiency. It is estimated that the electric power at present used in Baltimore for lighting and electric railways is 7,200 and for Washington 8,600 hp, and the required amount of power for this, it is believed, can be depended upon for all time. The wheels were run on horizontal axles for convenience in the driving connections; there will be two 500-kw generators on each shaft; each shaft has three pulleys including one to couple it with

the steam engine if required ; each water wheel is to have a capacity of 1,500 hp and 16 of these are included in the estimate ; the total cost is estimated at $2,537,430 ; the annual revenue expected from Baltimore and Washington is $737,250, and the probable net income $503,079.

A Central Station in Mining Work.—The "Eng. and Min. Jour.," Sept. 14, contains an article by Mr. Sprague in which he describes a central station at Scott Haven, Pa., which is said to be the first practical example on a large scale in coal mining, of a central station from which electrical energy is distributed to two or more adjoining mines ; the concentration of steam plant under one roof means very economical operation in every way besides giving a chance to select a site better suited to its purpose ; the power from this station is used for haulage, coal cutting, pumping, ventilating, etc. The article is reprinted in "Elec. Rev.," Sept. 25.

Rock Drills.—A translation in abstract of the article by Mr. Meissner which was mentioned in the Digest, Sept. 14, is published in the "Eng. and Min. Jour.," Sept. 21.

TRACTION.

The Lond. "Elec.," Sept. 13, also contains an illustrated description of this and of the Douglas-Laxey line, which, though a separate line, works in conjunction with this mountain road. Profiles of the roads are given, as also a diagram showing the flow of current into and out of the battery which is merely used as a regulator, the charging and discharging practically balancing each other. The discharge curves are very pointed and abrupt, while the charging curves are more even.

Operating Expenses of Railways.—The Lond. "Elec. Rev.," Sept. 13, reprints tables from the "Railway World," which are intended to bring up to date those published a year ago in that journal. They refer to the electric and cable railways in Great Britain. Only the Liverpool, South London, Birmingham and Edinburgh lines are considered. The data are brought up to last June. For the Liverpool line some of the figures are as follows : For December, 1894, and June, 1895, respectively, the expenses per train-mile, 13.1 and 14.38 pence; the receipts per train mile, 19.59 and 21.65, and the percentage of expenses to receipts, 66.87 and 66.42. For the City & South London line the corresponding figures are : Expenses, 15.36 and 16.07; receipts, 25.24 and 26.11, and the percentage, 60.86 and 61.55; these two lines run trains of almost the same weight when all the seats are occupied. Regarding the accumulator line in Birmingham the results are unfavorable again. The corrected expenses per car-mile for the years ending June, 1894, and 1895, were 17.06 and 20.6, and the percentage was 101.61 and 131.21, showing a very bad loss. The road is only three miles long and has a double track. The article is to be continued.

Snaefell Mountain Railway.—A description of some length accompanied by a number of illustrations is published in the "Elec. Ry. Gaz.," Sept. 28; some data regarding this road was given in the Digest, Sept. 14. The most novel feature is said to be the use of the central rail in place of the rack, which forms what is known as the Fell system; it is a double-headed rail carried on wrought steel chains; it is used both for traction and for the brake; each car carries two pairs of horizontal wheels for gripping this third rail; the line is five miles long and the greater part of the grade is 1 in 12; the current is obtained from an overhead trolley wire, but in place of the trolley wheel, a modification of the Hopkinson collector is used, which consists of a sort of rectangle hinged on one of its sides, on the top of the car, the other side forming the sliding contact with the trolley wire; each car contains two of these. The generating station is half way up the mountain; there is an accumulator station at the lower end of the line which contains 246 accumulators of an output of 176 amperes for three hours or 72 amperes for 12 hours; they are charged by the surplus current and discharged to help the machines when required; the cars are like those on the Douglas-Laxey line, each car having four single-reduction series motors; the total horse-power of the car motors is 100.

Signals on Railways.—A paper by Mr. Barnard, read at the convention of the New York State Street Railway Association, is reprinted in full in the "Elec. Ry. Gaz.," Sept. 21. He points out the advantages of having some means of communication, especially on a single track road having turn-outs; he considers that the telephone is the instrument which can best replace the telegraph in the hands of the motormen and conductors; he shows the advantages of a system of signals in case a car is late at a turn-out; if it is so much behind time that the rule forbids its proceeding, it drops a signal at the next turn-out where it is due, to meet a car, and then one of the crew of that car, answering the telephone, is told to proceed.

New York State Street Railway Convention.—A full report of the proceedings is published in the "Elec. Ry. Gaz.," Sept. 21, including reprints of the papers; those which are not abstracted above are as follows: a paper by Mr. Cole on "Are We Laying Too Many Miles of Track to Reach a Few People"; one by Mr. Norton on "Is a Freight or Mail Service Profitable or Unprofitable on Street Railways?" and one by Mr. Allen on "General Track Construction."

Electrolytic Corrosion of Water Pipes in Boston.—The "Eng. News," Sept. 12, publishes some brief abstracts from the annual report of the city engineer of Boston. An investigation was made, the results of which are as follows ; In certain places electrolytic action has taken place, pipes having been already more or less injured, and are subjected to permanent decay; excavations which were made gave only negative results, revealing no marked action, and yet not proving that the decay had not been accelerated by electrolysis; series action is confined to special localities where abnormal currents are flowing, but this action has been reduced to so small an amount that it is not now difficult to detect it; where such action exists special precaution in providing return feeders and connections with the piping system will generally reduce the difficulty to a small amount; it is impracticable to entirely eliminate electrolytic action, but by a constant inspection and the application of the well-known remedies the danger can be reduced to a minimum; the action at any point is liable to increase or decrease temporarily, and therefore tests made at any one time are not conclusive, one thousandth of a volt will cause electrolytic action; measurements of small differences of potential between water pipes and the earth indicate the direction rather than the amount of the current and are not entirely reliable unless special precautions are taken on account of the battery action, thermal effects and other disturbing influences; the most practical way of reducing the liability to injury is by finding the places where the action is occurring and requiring the company to provide suitable return conductors or make proper connections with the pipes or rails; special provision can be made for measuring the current from the pipes to the ground (this is not described, however,) and with devices of this sort installed at various places, the most reliable information can be obtained.

Electric Car Tests.—In the third installment of the serial by Prof. H. Hering in the "Elec. Ry. Gaz.," Sept. 14, he describes a test to determine the performance of a car over the entire route with no other car on the road at that time, in order to find the speed, current, drop in voltage and horse-power on various portions of the road; very complete records were taken and the results are plotted in the form of two large plates giving a series of curves on a distance base; in another diagram these results are superimposed for the outgoing and the return trips; a large table contains a summary of the numerical results obtained, from which much interesting data can be deduced.

Electricity on Elevated Railways.—According to the "Eng. News," Sept. 26, an ordinance has been introduced in Chicago authorizing an elevated railway along Wabash Avenue, which is to form part of a proposed loop line intended to connect the four elevated railway lines; electric power is to be used and the ordinance practically puts an end to the use of steam locomotives on these elevated lines, as three of them will use the loop and they will be operated by electric power, while the life of steam power on the fourth line is limited to three years.

Operating Cars on a 25 per cent. Grade.—The "St. Ry. Rev.," Sept. 15, contains an article by Mr. Foster, giving an illustrated description of the line in San Francisco, a brief description of which was given in the Digest, Sept. 7.

Montreal Street Railways.—An illustrated description of the railways in Montreal is given in the "Elec. Ry. Gaz.," Sept. 14 and 21, the latter including a description of the incline railway to the summit of Mt. Royal. The city at present contains about 95 miles of track.

Niagara Gorge Line.—An illustrated description of this line, which follows the gorge along the banks of the river from near the falls down to Lewistown, is published in "Elec. Eng.," Sept. 25.

Chicago.—A brief illustrated description of two of the largest power plants in that city is given in the "St. Ry. Rev.," Sept. 15.

Electric Car Heater.—See abstract under "Car Heating by Electricity" under "Power and Heat."

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Uniformity in Switches and Fuses.—A report of a committee of the German Union of Electricians is published in the "Elek. Zeit.," Sept. 5 ; their recommendations, which have been formally adopted by that body, are as follows : screws for fuses, switches, instruments, etc., should be made of the following sizes :

50	100,	200,	400,	700,	1,000 amperes.
¼	5/16	3/8	½	5/8	¾ inches.

(it appears that from 50 amperes upward this refers to iron screws); lead fuse plugs are to be made in six sizes so as not to be interchangeable, each two sizes differing 2 mm in length, as follows ; for 1, 3, 6, 10, 15 and 25 amperes the length of the plugs, of the Edison type, are to be 31, 29, 27, 25, 23 and 21 mm ; for lead strip fuses the distance between the centres of the screws, for 50, 100, 400 and 1,000 amperes, respectively, are to be 70, 80, 95 and 110 mm ; the following scale of sizes of wires is to be used, the numbers giving the cross-section in sq. mm, 1, 1.5, 2.5, 4, 6, 10, 16, 25, 35, 50, 70 and 95 ; the same scale of currents above given are to be used in general for designating and specifying apparatus. As no satisfactory results were reached regarding standards of lead strip fuses, a prize of $75 is offered for the best solution of the problem.

Dresden.—A French translation of the greater part of the article abstracted in the Digest, Aug. 3 and Sept. 7, is published, together with a large number of the illustrations, in "L'Ind. Elec.," Sept. 10.

New Lighting Station at Wilkes Barre—An illustrated description by Mr. Vail is published in the "Elec. Eng.," Sept. 25; it is a mixed station, containing arc, direct current, incandescent and alternating dynamos.

WIRES, WIRING AND CONDUITS.

Aluminium Wires.—According to "L'Ind. Elec.," Sept. 10, Mr. Charpentier-Page has made some experiments with aluminium wires for telegraphy. The metal contains 6 per cent. of copper and the density is 2.95;

the resistance per sq. mm, per km was 31.1 for the annealed and 33.29 for the hard wire; that of a similar wire of copper is 16.45 ohms; the tensile strength of a wire 2.3 mm in diameter averaged 28 kg per sq. mm, the maximum being 34.2 and the minimum 25.3; the wires will stand at least four bendings at the right angle without breaking. Aluminium wire has also been used by Grammont for the transmission of power at Esere; nothing further is said except that the junctions were soldered with success.

Rules and Regulations.—The rules for interior wiring in the city of Paris, which was abstracted in the Digest last week, are published in full in "L'Eclairage Elec.," Sept. 1.

Construction and Maintenance of Telegraph Lines.—A paper by Mr. Taylor, read at the recent Montreal Convention of the Association of Railway Telegraph Superintendents, is being reprinted in the "Elec. Age," beginning with Sept. 14.

ELECTRO-PHYSICS AND MAGNETISM.

Molecular Electricity.—An article by Prof. Poynting on this subject is begun in the Lond. "Elec.," Sept. 13. He follows out the idea of carrying down to the molecules and their interspaces, the electric and magnetic relations which exist between large masses and around large circuits, leaving the ether out of account. He starts out with the hypothesis that electrical and chemical forces are identical, that electrification is a manifestation of unsatisfied chemical affinities, and that chemical union is a binding together of oppositely charged atoms or groups of atoms. An electrostatic field may be expressed as consisting of lines of force each of which begins at an electropositive atom and ends at an electronegative one; such lines flashing along laterally with the speed of light, give rise to the phenomenon called an electric current; it is supposed by some that proper metallic conduction is but a modification of the same process which goes on during electrolytic conduction; he endeavors to work out nearly all the phenomena of electricity and magnetism on an electrolytic basis.

Electrodynamic Solar System.—An Academy note by Mr. Zenger is reprinted in "L'Ind. Elec.," Sept. 10, and "L'Elec.," Sept. 14. Some years ago he described an electrodynamic apparatus consisting of a hollow copper sphere turning in an electromagnetic field, for showing the movements of the planets in their orbits; in the present note he describes an improvement consisting of a third magnet which produces the planetary perturbations.

Invention of the Electromagnet.—A translation from the French of Mr. Boistel's recent article in "L'Eclairage Elec.," July 20, relating to the discoveries of Arago, is published in the Lond. "Elec.," Sept. 13.

Causes of Atmospheric Electricity.—The "Elec. Rev.," Sept. 18, reprints from the "Nineteenth Century" an article by Prince Krapotkin; it is a brief summary of the views of various experimenters.

ELECTROCHEMISTRY AND BATTERIES.

Cells of High E. M. F.—Several forms of cells are briefly described by Mr. Fitzgerald in the Lond. "Elec. Rev.," Sept. 13. It appears that the use of peroxide of lead with a platinum terminal, used with zinc in a salt or acid solution, was suggested by De la Rive more than 40 years ago. A lead conductor may be substituted for the platinum, the peroxide may be obtained electrolytically from a cheap by-product, and the zinc may be placed in oxalic acid, which will then form a battery which is not necessarily a primary one, as it is most economically worked by recharging it, while it is at the same time not a secondary battery, because it is not worth while to attempt to recover the zinc; one reason for not throwing away the peroxide pots is that they improve very much by recharging, in one case they gave 2.5 times as much after the first recharge; it is not to be recommended to store such pots for a long time and for this reason they cannot compare with the Leclanche, but he thinks it much better than the Grove or Bunsen; a freshly mounted couple of the size of a No. 2 Leclanche gave 2.52 volts, its internal resistance was .67, the current .78 and after 24 hours the voltage had fallen to 2.50. An important modification consists in placing the zinc in a solution of caustic potash of soda of a density of 1.20, in a second porous pot; the voltage was 3.05 but the internal resistance was 2.44, which is very high and depends upon the porosity of the porous cups, the peroxide itself being contained in a porous cup; he found this cell not only useful but also economical for charging pocket accumulators, one cell being quite sufficient for an accumulator. When using acid electrolytes only retort carbon and graphite are suitable, and the only way to establish a reliable contact is by means of a disc of platinum.

Electrolysis of Chloride of Calcium Solutions.—The article by Dr. Schoop (see Digest, Sept. 21,) is concluded in the "Zeit. f. Electrochem.," Sept. 5. He gives the tabulated results of further laboratory researches, from which it appears that the output of active chlorine becomes less the greater the current density; for a density of 42 amperes per sq. m of anode surface, the percentage output is 82, for 70 amperes it is 72, and for 150 amperes it is 48. Among other things he states that when both electrodes consist of platinum the increase of resistance can be obviated very easily by changing the direction of the current as soon as the voltage exceeds a certain amount; in that case the mechanical cleaning of the cathode, as in the Hermite apparatus, becomes unnecessary; but he seems to find that the result of such commutation is that the output becomes exceedingly small. Copper or zinc may be used as the cathode without diminishing the efficiency, but when graphite replaces the platinum-iridium as an anode the diminution in the amount of bleaching substance produced becomes very great. In all his researches free chlorine was never produced. In conclusion he gives some results of tests with a 3 per cent. solution of chlorine of sodium, which also show that with increasing current-density the output of bleaching material becomes less; he thinks it probable that the output depends partly on the formation of chlorates; in chloride of calcium solutions the formation of chlorates increases with the current-density at the anode and with the alkalinity of the solution.

Action of Electric Current on Fused Sulphurets.—A correspondent, R. W. P., to the "Eng. & Min. Jour.," Sept. 21, refers to the recent article on this subject by Mr. Garnier (see Digest, Sept. 7), and states that a much more valuable application of electricity to the extraction of sulphur from sulphurets has been neglected; the discovery was made by Dr. Eames and consisted in passing an electric current through broken sulphuret ore at a red heat in a closed vessel, in which case the sulphur becomes separated and drops in a molten condition in a receiver placed below. It has been applied on a commercial scale to gold ores and can be conducted continuously; he has lately tested it on a considerable scale and is quite satisfied as to its commercial value. The operation is very simple; in an ordinary clay crucible holding say 10 pounds and having a cover, two arc light carbons are introduced through two holes in the cover 4 in. apart, the carbons reaching within 1 in. of the bottom; another small crucible is connected by a tube with the other; when heated to a cherry red heat a current from two or three bichromate cells is passed through the mass and the circuit will be completed as long as any sulphur remains in the ore, but will be broken as soon as all the sulphur is extracted, which takes from 4 to 6 hours, or in ton lots, about 8 hours. One of the important results of this roasting is an entire absence of kernel roasting; gold or silver ores can then be amalgated without further treatment. The process can be carried out most economically and the solid sulphur obtained ordinarily pays all the expense of the treatment.

Smelting Refractory Ores in the Electric Furnace.—The "Elec. Eng.," Sept. 25, contains a short article by Mr. Burton, giving the results in a general way of recent investigations in this direction. (Neither the furnaces nor the method are described, but it is presumed that he refers to the well-known method of heating an electrode in an electrolyte by means of a strong current at several hundred volts. When the ore is of a "rebellious" character he finds that "by placing proper flux in the solution the metal in the ore will separate and run from the ore according to the different degrees of heat required to melt the different metals" in ores containing lead, copper, gold and silver, the lead will separate, first being found in the bottom of the tank in globules, and, as the heat increases the silver will flow, then the copper and then the gold, the rock being finally consumed or reduced to an ash. With 2,000 amperes at 250 volts and an ore containing 20 to 30 per cent. of rebellious substances, the treatment of one ton requires 35 to 40 minutes, each receptacle being capable of treating one ton. He has treated many hundred samples of ores in the California mines and finds that the "chemical properties contained in the ore have much to do with the rapid heating" and that the more rebellious the ore the less current is required to treat it, (but nothing is said of the voltage nor of the energy). He found no ore which could not be successfully handled; he separated out gold, silver, copper, lead, zinc, antimony and all by-products, such as arsenic and sulphur; the process is claimed to be much cheaper than any others in use, when there is water-power near at hand; none of the metal contained in the ore is wasted or lost. "Remarkable success" has been attained in Canada with the treatment of nickel ores; the best so far produced by the other methods is a nickel matte of 21.25 per cent. of nickel which requires about four months, whereas by the present system a ton of ore is reduced in 40 minutes; the present price of nickel is 25 cents per pound, and by this process this is claimed to be reduced to 15 cents.

Recent Advances in Electrochemistry.—An abstract of the lecture by Mr. Richards which was noticed in the Digest, May 18, is published in the "Elec. Age," Sept. 14.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Very Sensitive Apparatus.—In an article by Mr. Armagnat in "L'Eclairage Elec.," Sept. 10, he points out the effect of the attraction of gravitation between the movable and the fixed parts of very sensitive apparatus; upon investigation he was astonished to find that the force of attraction of gravitation in a galvanometer was about as great as the E. M. Fs. He develops some formulas and applies them to a special case. He states that much greater sensitiveness can be obtained without the interference of the attraction of gravitation, by making the forces acting on the needle proportional to the difference between the magnetic and the gravitational forces. Irregular actions in Thomson galvanometers are often attributed to the presence of iron in the copper of the coils or to electrostatic actions, and he shows that such actions can be explained by the existence of gravitational forces; he thinks that the effect of iron in copper has been greatly exaggerated; the electrostatic attractions are the most important.

Measuring the Coefficient of Self-Induction of a Coil.—An abstract of an article by Mr. Nikolaieve from the "Jour. de Physique," Vol. 4, page 367, is published in "L'Eclairage Elec.," Sept. 7. The coil is short circuited and is suspended in the interpolar space between two fixed coils traversed by a sine current, or in the interior of a single coil, the axis being at an angle of 45 degrees with that of the alternating field; the parts of the fixed coils nearest the moving coils are connected to earth to avoid the effects of electrostatic charges; the field is excited by currents of different intensities and different periods, and the corresponding deflections are measured, from which the coefficient of self-induction may then be calculated by a formula which he deduces.

Standard Cell.—According to the "Zeit. f. Elek.," Sept. 5, Mr. Mauri, in a paper published in May, made extended researches of the effect of temperature and of the concentration of the zinc sulphate electrolyte, on the E. M. F. of the Clark cell and found for the temperature coefficient the value 0.00105. By replacing the sulphate of mercury with acetate of mercury a cell will be obtained whose E. M. F. is quite constant. Regarding the polarization of standard cell, he believes that within certain limits it is proportional to the current strength.

Length of the Metre.—The Lond. "Elec.," Sept. 13, states that according to the International Metric Congress, the length of the metre is said to be 1,553,663 times the length of the standard wave of red light.

Measuring the Insulation Resistance of Live Leads.—In the "Elec. Jour." (Chicago), Sept. 15, Prof. Anthony gives a brief and clear description of the method of measuring insulation resistance of live circuits with the use of nothing more than a voltmeter, when there is a ground on one or on both sides. The formulas which he deduces are as follows: If there is a ground on one side of the circuit only, say the positive, then connect the voltmeter between the other side and the ground and read the deflection in volts; let this reading be represented by v and let V be the voltage, measure with the same instrument, between the two leads, and let r be the resistance in ohms of the voltmeter itself; then the x of the ground on the positive lead; that is, the insulation resistance of that lead will be equal to

$$x = \frac{V - v}{v} r.$$

When grounds exits on both sides this will give a fairly correct result if the insulation resistances are high, but when they are as low as a few thousand ohms the results will be quite incorrect when grounds exist on both sides. For the latter case he deduces the following formula: repeat the same test as that described above and let the results be represented by the same letters, the resistance between the positive and the ground being again represented by x; repeat the same test by placing the voltmeter between the positive and the ground and represent the voltmeter reading in that case by v' and the insulation of the negative lead by y, then,

$$x = V - \frac{(v + v')}{v} r$$

and

$$y = V - \frac{(v + v')}{v'} r.$$

An example is worked out.

Photometry of Arc and Incandescent Lamps.—A series of articles by Prof. Stine is begun in "Elec. Ind." for September. The object of this series is "to clearly state the elementary theory and practice" of photometric measurements; the present portion is introductory in its character.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Common Return Circuit for Telephones.—"Elek Zeit.," Sept. 5, contains an article by Mr. Christiani in which he points out the advantages of common return circuits in telephone installations; while admitting that the metallic circuit system is the most satisfactory and the one which we are probably coming to ultimately, yet, there are many places where this is too expensive and too complicated, and for these he suggests the common return system in which the return wires are all connected at the station and cross-connected at convenient points near the extreme ends; regarding the metallic circuits he states that the question is not, whether metallic circuits will be used, but when they will come into universal use.

Telephone Calling Batteries.—The "Elek. Anz.," Sept. 12, publishes a diagram, accompanied by a description, of the system of connections of the calling batteries in the principal central station in Paris.

MISCELLANEOUS.

High-Voltage Shocks.—Referring to an article in the "Elec. World" some months ago, Mr. Nizzola in "L'Elettricista" for September, states that in the high-voltage plant installed in Frankfort, Germany, a workman was carrying out some repairs in the distribution system when he touched a bare copper wire while standing in good contact with the ground; the wire was connected with the middle conductor of a concentric cable, the external conductor of which was maintained at about the same potential as the earth, owing to the capacity effects, the length of that circuit being 18 miles; he thus received a shock from 2,900 volts; he immediately fell to the ground and remained half an hour apparently dead; a bright spark was seen when he broke contact; artificial respiration and throwing cold water on the breast gradually restored life, but he remained for a whole day in a dazed condition; he resumed his work again the next day with no other effects remaining but a bad burn on the hand; he had no recollection whatever of the accident. The author strongly recommends the injection of sulphuric ether which he recommends that every electrician should carry in his pocket, together with the necessary appliances, in order to try the effects; the injection should be made under the skin near the heart.

Electrotherapeutics.—The "Bul. Soc. Int. des Elec." for July contains a long paper by Dr. Tripier, beginning with the history of the subject dating back to 1740; it is of interest chiefly to physicians.

British Association Meeting.—The presidential address at the Ipswich meeting, by Sir Douglas Galton, is being reprinted in the Lond. "Elec. Eng.," beginning with issue of Sept. 13; it is discussed unfavorably in the current issues of the Lond. "Elec. Rev." and Lond. "Elec." The paper by Maj.-Gen. Webber on "Light Railways as an Assistance to Agriculture," is reprinted in the Lond. "Elec. Eng.," Sept. 13. The address of Prof. Hicks is commented on unfavorably in the Lond. "Elec." while that of Prof. Vernon-Harcourt is briefly referred to in the Lond. "Elec." and "Elec. Rev."

Biographical.—The Lond. "Elec.," Sept. 13, publishes a full plate steel portrait of Wm. Sturgeon, which is accompanied by a brief biographical sketch and illustrations of his electromagnet.

Protection from Lightning.—A Circular of Information having this title, by Mr. McAdie, of the U. S. Weather Bureau, is published under separate cover as Bulletin No. 15 of the U. S. Department of Agriculture. The pamphlet is rich in statistics and contains numerous practical deductions; it contains illustrations of lightning conductors, of objects struck by lightning and some photographs typical of lightning discharges. Among the more important and interesting statistics and deductions are the following: During the five years, 1890 to 1894, an average of 224 lives per year were lost in the United States due to violent wind storms, tornados and lightning; during the nine years ending in 1893 there were in the United States 4,175 fires caused by lightning, representing a total loss of over $14,000,000; during the ten years ending in 1893, 2,679 barns, 129 churches and 831 dwellings were struck by lightning; their geographical distribution is given; the loss of life and property in 1894 is discussed in detail; the region of the greatest number of thunderstorms is in the southeastern part of the United States; an interesting result of the statistics is that there is a decreased liability to accident in thickly settled communities, the risk in the country being five times as great as in the city; lightning rods are hardly necessary for dwelling houses in city blocks, a considerable protection being afforded by the tin roofing, cornices, etc. If 1 represents the frequency of lightning strokes in a chalk formation, 2 will represent it for marl, 7 for clay, 9 for sand and 22 for loam; the oak is the tree most frequently and the beach the one least frequently struck; the statistics show that the trees which are struck are not necessarily the most prominent, but rather those which are near ditches full of running water or near temporary water courses. A theory of lightning conductors is discussed; the function of the lightning rod is two-fold, that of conducting the charge to earth and that of preventing a disruptive discharge by silent neutralization of the cloud electrification. Sir Wm. Thompson (Lord Kelvin), at the British Association meeting of 1888, stated that there is "very strong reason to feel that there is a very comfortable degree of security, if not of absolute safety, given to us by lightning conductors made according to the present and orthodox rules." A set of rules for the erection and maintenance of rods is given; one should use a good iron or copper conductor, and if the latter, one weighing about six ounces to the foot, preferably in the form of tape; iron appears to be as efficient as copper and it should weigh about 35 ounces to the foot; a sheet of metal is better than a rod of the same cross-section; the nature of the locality will determine the need of a rod; the very best ground obtainable is a very poor one, and one can therefore not overdo the matter in the making of a good ground; the earth plates should be buried in damp earth or running water; when the conductor is near water or gas mains it should be connected with them; the neighborhood of small fusible gas pipes and indoor gas pipes should be avoided; the top of the rod should be protected from corrosion and rust; independent grounds are preferable to water and gas mains; clusters of points are recommended; chain or link conductors are of little use; very little faith is placed in so-called area protection; some uncertainty exists in regard to the return shock which is caused by the inductive action of charged cloud on distant objects; regarding the indifference of lightning to the path of least resistance, Lodge says "it is simply hopeless to pretend to be able to make the lightning conductors so much the easier path that all others are out of question"; the path will depend largely on the character of the flash; while parts of a building protected by a rod may be struck, the majority of flashes in our latitude are not so intense but that a well-earthed lightning rod makes the most natural path; there are many instances, however, where buildings were struck below the rods; buildings may be damaged without having been struck at all, as by an induced spark near escaping gas; there is no good reason why a place once struck may not be struck again; it sometimes makes but little difference whether

trees are higher than the adjoining buildings or not, the lightning may strike them indiscriminately; it is not judicious to stand under trees, in the doorway or barns, close to cattle or near chimneys and fire places, but there is no reason to try to insulate oneself; small steel objects do not attract lightning; if a person is struck they should at once try to restore consciousness, as lightning often brings about suspended animation rather then death; the instructions for resuscitation, as published in THE ELECTRICAL WORLD, are reprinted. No better illustration of the value of lightning conductors can be had than the one on the Washington monument; it appears that a barn is more liable to be struck when filled with crops than when empty.

Biographical.—A large full plate portrait of Ampère is published in the "Elec. Jour.," Chicago, Sept. 15.

New Books.

THE MANAGEMENT OF DYNAMOS. By G. W. Lummis-Patterson. London: Crosby, Lockwood & Son. 214 pages, 81 illustrations. Price, $1.

This book, as the title indicates, is written for the use of mechanics, engineers and others having charge of dynamos in practical operation. The opening chapter is on electrical units, which are fully and clearly explained without verbiage or resort to any but the simplest of mathematics; following are two chapters devoted to the fundamental principles of magnetism and the theory of dynamo-electric machines, written in a simple conversational style which commends itself to all classes of students and practical men.

The author next discusses armatures and field magnets, the construction of which is explained in considerable detail; in this section of the book various forms of armature cores and windings, commutators, brushes and holders, magnet frames and windings, etc., are described and directions given for the proper handling and repair of the several parts of a dynamo, as well as for making connections, taking characteristics, curves, etc.

The third section of the book is devoted entirely to subjects of a purely practical character, including instructions for the setting, preliminary examination and starting up, of dynamos, which are of vital importance to engineers in charge of plants too small to justify the employment of a thoroughly educated and experienced electrician. Other important subjects are the adjustment of brushes, sparking and its various causes and remedies, machines in operation, coupling up in series and parallel, regulation, distribution of load and the proper precautions to be observed in withdrawing a machine from a circuit which is being served by other dynamos at the time. These matters, while naturally of a more or less commonplace character, are given the full and careful attention they deserve, the explanations and instructions being free from any perfunctory tone.

Faults in dynamos, their probable and possible origin and methods of locating and correcting them, are considered at length in the latter portion of the book. While many cases are cited which might seem to carry their own explanation and require no attention in a book of this class, none of them will appear to be superfluous in the judgment of those who are familiar with the seemingly inexplicable blindness with which some station men ignore the most obvious causes of trouble and hunt frantically for hours in every direction but the right one, or else sit down in blank despair and await the coming of an "expert."

Although the author claims a less ambitious aim for his work, the book forms an admirable elementary exposition of the fundamental principles of dynamo design and construction in addition to providing wholly practical and useful directions for the proper handling of electrical electrodynamic machinery. The illustrations are sufficiently simple for the guidance of the least educated persons to whose care such apparatus should be entrusted, but their efficacy is by no means sacrificed to this end. The book is printed in large type, on good paper, and substantially bound in cloth.

TELEPHONE SYSTEMS OF THE CONTINENT OF EUROPE. By A. R. Bennett. London: Longmans, Green & Co. 436 pages, 169 illustrations. Price, $4.50.

The writer of this work, who is general manager and chief engineer of the New Telephone Company, Limited, of Great Britain, and has been connected in higher capacities with various telephone companies since 1880, is amply qualified for the task which he has undertaken—to describe the telephone systems of the continent of Europe. From the introduction it appears that the work owes its origin to a desire to sift the many assertions made with respect to the condition of telephonic service on the continent, the English advocates of low rates having asserted that very low charges obtain there, while the apologists for the existing British monopoly either denied the truth of the statement or declared the conditions existing there, as to quality and cost of service, etc., to be radically different from corresponding ones in the United Kingdom.

The results of the investigations made are summarized in an introduction, which also includes a lengthy discussion of English rates and quality of telephone service, and a consideration of the various questions relating to the nationalization and municipalization of the telephone business now before the public. Owing to the great experience of the writer on the subject, and the many different topics discussed having a relation to the above points, this chapter will be found an extremely valuable one to those desiring to know the present status of telephone business and service in Great Britain.

The succeeding chapters take up 26 European States in turn, the most space being allotted to Belgium, Sweden and Switzerland. The subject-matter of each chapter is given under a number of heads, as follows: History and Present Position; Services Rendered to the Public; Tariffs; Right of Way; Switching Arrangements; Hours of Service; Subscriber's Instruments; Local and Trunk Line Construction; Payment of Workmen and Operators; Statistics. Much technical matter is contained in the sections on "Switching Arrangements" and "Local and Trunk Instruction," the various switchboard systems in use, and the different varieties of metal and ornamental poles, house attachments, etc., being described and well illustrated. In the section on "Services Rendered to the Public" information is given as to the administrative rules affecting subscribers, regulations with respect to suburban and long-distance service, public telephone stations, etc. The section on "Tariffs" very fully considers the rates of charge for local and trunk service, public station service, and so on.

To those who desire to obtain complete and exact information as to the condition of telephonic service of Europe this work will prove invaluable, while those engaged in the construction of telephone lines and exchanges will find more practical information here in relation to these subjects than in any other book of which we know. The work, indeed, is one that should be in the hands of every person interested in the telephone business, whether in a financial, professional or industrial capacity.

ELECTRICITY AND MAGNETISM. A Mathematical Treatise for Advanced Undergraduate Students. By Francis E. Nipher, A. M. St. Louis: J. L. Boland. 425 pages; 145 illustrations: Price, $3.25.

This book contains a very clear statement of the fundamental elements of the electromagnetic theory. The application of the general laws of this theory to specific practical problems is profusely illustrated by a very large, judiciously selected, and carefully worked out series of numerical examples. These examples form one of the several excellent features of this elementary treatise.

In the introduction the relation of physical units in general and of the electromagnetic units in particular to the fundamental units is explained. Then follow two short chapters on gravitating systems in which the meaning of potential and potential energy, of lines and tubes of gravitation force and their distribution in space, is carefully worked out and illustrated by examples which one does not ordinarily, but should, find in books on electromagnetism. For instance, the student is informed that two gramme-mass particles of gravitating matter at a unit's distance attract each other with $\frac{1}{1.543 \times 10^7}$ dynes, and that, therefore, the astronomical unit of mass is 3928 C. G. S. units of mass. Again the gravitation potential on the surface of the earth is calculated and found to be 2.454×10^8 ergs.

This preliminary work gives the student the necessary confidence for taking up a similar quantitative analysis of electromagnetic phenomena and for this reason it is very desirable.

In the following four chapters static electric and magnetic phenomena are discussed. The relation between tubes of forces and tubes of induction is very clearly set forth, and the meaning of the electromagnetic constants of the field, that is, specific inductive capacity and magnetic permeability, is stated with much definiteness. The applicability of a quantitative relation between force and induction flux produced by that force, resembling in form Ohm's law to the determination of the distribution of the electric flux, is explained in a neat and original manner. Among the numerous examples of this part of the book those relating to the calculation of the capacity of condensers of various forms to the determination of the moment of a magnet in absolute measure, and to the calculation of the dimensions of ohmic resistance in terms of the electrostatic units, can be cited as striking illustrations of the good judgment and didactic ability of the author.

The chapter on constant electric currents deals with the definition of the electromagnetic unit of current; the description in terms of lines of force of the magnetic field which accompanies an electric current; the energy stored up in this field; the reacting or induced electromotive forces which we detect in conductors when the magnetic field surrounding them varies either in consequence of the variation of the strength of the field or in consequence of the relative motion of the conductor and field; the law of magnetoelectric induction; and, finally, the application of the principles discussed to the mode of operation of dynamo and motor. The chapter closes with a discussion of the electromagnetic measure of the other two fundamental quantities, that is, the electromotive force and the resistance, and several well-chosen numerical examples follow. This chapter might, perhaps, be improved by adding to it the following features: The equivalence of a simple magnetic shell to a current flowing through a loop of wire which coincides with the boundary curve of the shell should be discussed much more fully than the author has done. The distinction between lines of force and tubes of induction should be more carefully observed, especially by an author like Prof. Nipher, who has contributed so many valuable hints bearing on the distinction between flow of force

and flow of induction. A current is accompanied by the same number of lines or tubes of force in perfect vacuum, as it is in a medium of permeability μ, but the number of lines or *tubes of induction* which accompany it in the second case is μ times as large as in the first. The coefficients of self and mutual *induction* are measured not by the number of lines of force, but the number of lines (or, better still, "tubes") of *induction*. To be sure, this lack of distinction between the two terms is almost universal, but Prof. Nipher is, in the reviewer's opinion, just the man to start the reform. The idea of magnetomotive force should be introduced here, and then Maxwell's generalization of the law of induced electromotive force and the law of induced magnetomotive force could be stated in this chapter, and the hypotheses on which this generalization is based could be discussed briefly without in any way departing from the original design of preserving the character of the book as elementary as possible. The advisability of such a step will be admitted by all lovers of the Maxwellian theory.

The chapter on variable currents from constant electromotive forces is most excellent. The work which an electromotive source has to do to charge a condenser or to establish the magnetic field which accompanies every electric current must be understood very clearly by the student before he enters the region of alternating-current phenomena. Prof. Nipher seems to appreciate this better than any previous writer of electrical text-books has ever done; but, then, he wrote his book not because he had nothing better to do, but because he has had a long experience as a teacher, and wishes that others may be benefitted by it. This, in fact, is the characteristic feature of the book. One more remark on this chapter will suffice. On page 242 the following interesting fact is stated: "Hence whatever may be the resistance of a non-inductive conductor, connecting a condenser with a source of electricity having a fixed potential, half of the energy received by the conductor will be wasted in the conductor, and the other half will be stored in the condenser." The word "non-inductive" is superfluous and misleading because half of the total work will be wasted and the other half stored up even if the conductor has any self-induction and mutual induction, and even if any other wasteful processes like hysteresis (excepting leakage) should accompany the operation of charging the condenser. The reviewer employs this interesting relation to show to young students the necessity of electrical oscillations.

The chapter on alternating currents, including a very brief discussion of polyphase systems, is complete and compact. The analytical method is given preference to the graphical, as it should, but the last method receives also a proper share of attention. The magnetic properties of iron and the experimental methods of determining them are discussed very fully in the next chapter. This chapter is an excellent abstract of Ewing's splendid investigations in this field. Steinmetz's method for calculating the hysteresis losses is also explained, and his formula is called by the correct name "empirical formula," and not "Steinmetz's law of hysteresis," as is usually done by people who have no conception of the true meaning of the expression "physical law."

The book concludes with a chapter on the dimensions of units and a chapter of useful special problems. Among these should be mentioned the calorimetric determination of an electric current, calculation of iron and copper losses in armatures and transformers. A chapter on Hopkinson's theory of magnetic circuit and its application to the theory of designing dynamos, motors, alternators and transformers, might have been added to meet the demand of electrical engineering students. It must be admitted, however, that a student who has mastered the contents of this book will have no serious difficulty in constructing his own method of designing electrical apparatus for any specific duty.

The reviewer has no hesitation whatever in recommending this admirable work to all teachers and students as one of the best, if not the best, elementary treatise on the elements of theoretical electrical engineering.

A New Alternating-Current Arc Lamp.

The accompanying cut shows an alternating-current arc lamp which is being manufactured by the Fleming-Spence Electric Company, of 652 Hudson Street, New York. The lamp belongs to the "chain feed" class, which makes it particularly well adapted for interior work and in all places where a short lamp is desirable, the total length of this one being less than 24 inches. The mechanism is exceedingly simple, the only moving parts being the chain wheel or drum, which carries a large escapement wheel on its spindle, the solenoid plunger and lever, and the carbon carriage.

The solenoid plunger is made of a strip of sheet iron, coiled so as to obtain the effect of a laminated core and wrapped with stout cord in order to avoid direct contact between the plunger and the solenoid spool. The solenoid spool is made of fibre to eliminate all heating effects due to eddy currents and the combination of the fibre spool and cord-covered plunger obviate the metallic rattle and vibration which would otherwise be present. In order to further obviate the humming and vibration noticeable in alternating-current lamps the case has been made of non-conducting material.

The solenoid coil is composed of comparatively few turns of unusually heavy wire, and is connected in series with the arc. The lamps are ordinarily made to burn with a difference of potential of 28 volts and a current of 14 amperes, though they can be furnished to operate equally well with any desired current from four amperes up. The absence of all springs

Fleming Arc Lamps.

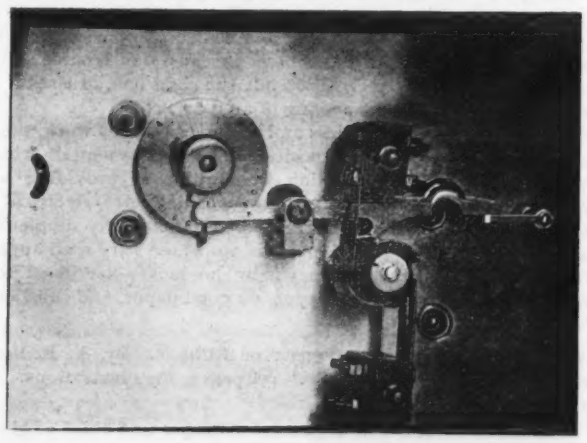
and gears naturally tends to lessen the liability to get out of order, besides contributing to the general minimizing of noise during operation.

An Electric Time Switch.

The desire on the part of the central-station managers to strike some happy medium between unprotected flat contract service and an exclusively meter service has led to the production of several devices for the purpose of determining the exact number of hours in 24 during which consumers shall be able to draw on the service mains. One of the simplest of such arrangements is shown in the accompanying engraving, which represents an automatic time switch manufactured by Jerome Redding & Co., of Boston.

The instrument consists of a double-pole switch which is connected in circuit where the wires enter a building, and which is opened and closed at pre-determined hours by cams actuated by an eight-day clock movement. Referring to the engraving, the dial on the left is driven by the clock-movement, which is behind the base; this dial carries two cams, one of which closes the switch and the other opens it. The cams can be turned on the dial so as to set them at any desired points, a jam nut being provided to secure them wherever they are set.

The switch is of the well-known rotary ratchet type, and is revolved by



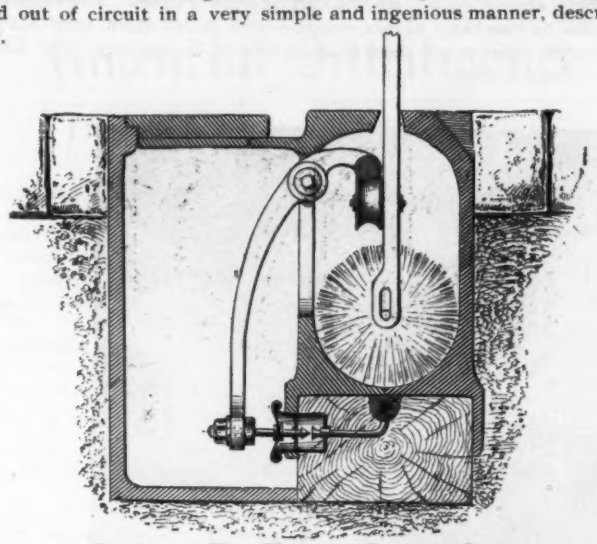
Automatic Time Switch.

a powerful spring. The switch barrel is normally prevented from revolving by two horizontal levers, as shown in the cut. When the switch is in the position of "no current," the lever controlled by the "lighting' cam holds it; when the "lighting" cam comes around it depresses this lever and the switch-barrel turns through a quarter revolution, completing the circuit and being stopped by the lever under the control of the "extinguishing" cam. At the proper hour this cam trips its lever and the barrel turns through another quarter revolution, breaking the circuit and passing again under the control of the "lighting" cam lever; and so on.

The device is particularly applicable to the control of show-window and similar lights, but can obviously be used in any case where it is practicable to pre-determine the period of service, such as with job printing-office motors, apartment house lights, etc.

A New Conduit Railway System.

We illustrate herewith a new conduit railway system which possesses several points of novelty and ingenuity; the system is being exploited by the La Burt Electric Railway Company, 123 Liberty Street, New York, and is the invention of Mr. John La Burt, the company s engineer. It belongs to that class of conduit railways in which the working conductor is sectional, the sections being connected with the supply mains only when cars are over them. The La Burt system, however, differs radically from others of this general class in that there are no magnetic switches or contact-making devices, the working conductor being put in and out of circuit in a very simple and ingenious manner, described below.



SECTIONAL END VIEW AT CONTACT BOX.

The conduit is located just outside one of the rails and contains only one conductor, the rails being used for the return, as in the trolley system. The conductor, as above stated, is sectional so far as conducting material is cencerned, but the ends are mechanically joined by a non-conducting and flexible device which behaves exactly as a universal joint. Each section of conductor is supported, at the ends only, upon the arms of two bell cranks ; the other arms of these carry contact fingers which, when the conductor is raised, complete a connection between the mains and the conductor section which is supported by the crank levers.

The contact device consists of a ɹ-shaped plow which hangs from the side of the car and carries two wheels, similar to trolley wheels, on the extremities of its horizontal portion within the conduit. These wheels run *under* the sectional conductor and raise each section of it as they reach that section, completing, by means of the bell-crank levers, connection between the sectional conductor and the mains. As the car passes beyond a given section, the contact wheels being no longer beneath it, that section drops down, cutting itself out of circuit.

The sections are made sufficiently long to insure the dropping of one end while the other end is held up, the flexible connections between the individual sections permitting this action. Therefore, as the car comes to a section only the nearest end of the conductor-section is raised, the bell-crank at that end putting it in circuit; when the car is over the middle of the conductor-section, the far end will have been raised and an additional contact made there, the conductor section being made of pipe to secure the proper rigidity. As the car moves farther and farther from the first end of the section, that end sags and finally drops to its lowest position just before the contact wheels reach the far end; as there is a contact at this end, the breaking of contact at the end in the rear of the car produces no spark. In raising the far end of the live section under the car, the near end of the section just beyond is raised, so that when the contact wheels pass from a given section, the section beyond is in circuit and ready to supply current. The two wheels of the contact device are placed sufficiently far apart to straddle the break between sections and obviate any sparking there.

The plow also carries a circular wire brush, as shown in the engraving, which is set at such an angle that the friction against the sides of the conduit causes it to revolve and clean the walls of the conduit as the car passes along.

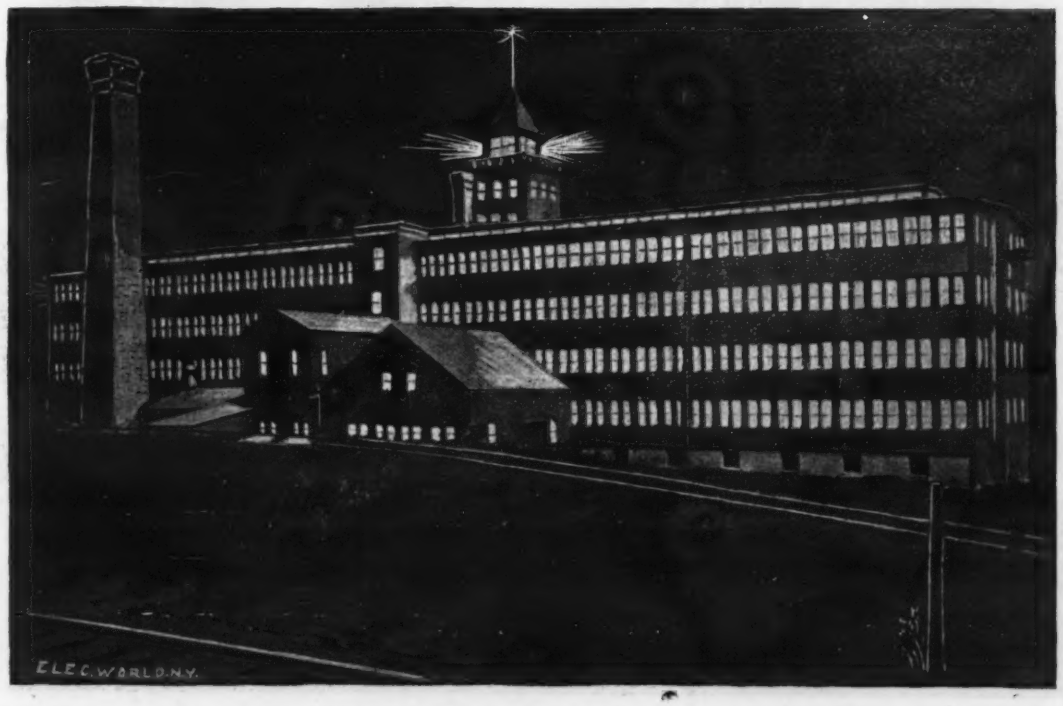
The contact plow is movable vertically on the car truck, but is normally held up by a strong spring. In the event that it should become desirable to remove the contact wheels from the conductor the motorman can depress the plow, allowing the sectional conductor to break contact with the mains, and also dropping the contact wheels from the conductor entirely.

At each break in the working conductor a contact box is located, access to which is readily had by removing the cover, which does not involve the removal of any pavement or the disturbance of the track or conduit structure.

Is Night Work in Factories Profitable?

It has long been the opinion among manufacturers that night operation of factories is not desirable from a financial standpoint, though large numbers of them are forced to it by stress of circumstances. The Bryan Marsh Company expresses doubts as to the accuracy of this opinion as applied to the manufacture of incandescent lamps, having tried running 22 hours out of 24 during the past month, after some experimental runs up to midnight in order to ascertain the practicability of night work.

The results obtained by the above-named company go to show that the venture is a success, the only real disadvantage being the greater rate of wages paid for night labor as compared with day work. Indeed, a part of the work is accomplished more conveniently at night than in the daytime, the glass-blowers and sealers being compelled to darken the work rooms when working during ordinary hours. In exhausting, the most important portion of the work is as easily done without sunlight as with it, while for photometric work the conditions at night are ideal. Attaching the lamp bases is done only during the day hours, but the final testing is accomplished equally well by day or night.



LAMP FACTORY IN OPERATION AT NIGHT.

The total results show such a slight additional cost that the company considers it negligible as against the consideration of being in position to fill orders promptly. In this connection it is interesting to note that the Bryan-Marsh Company has largely increased the variety of its product,

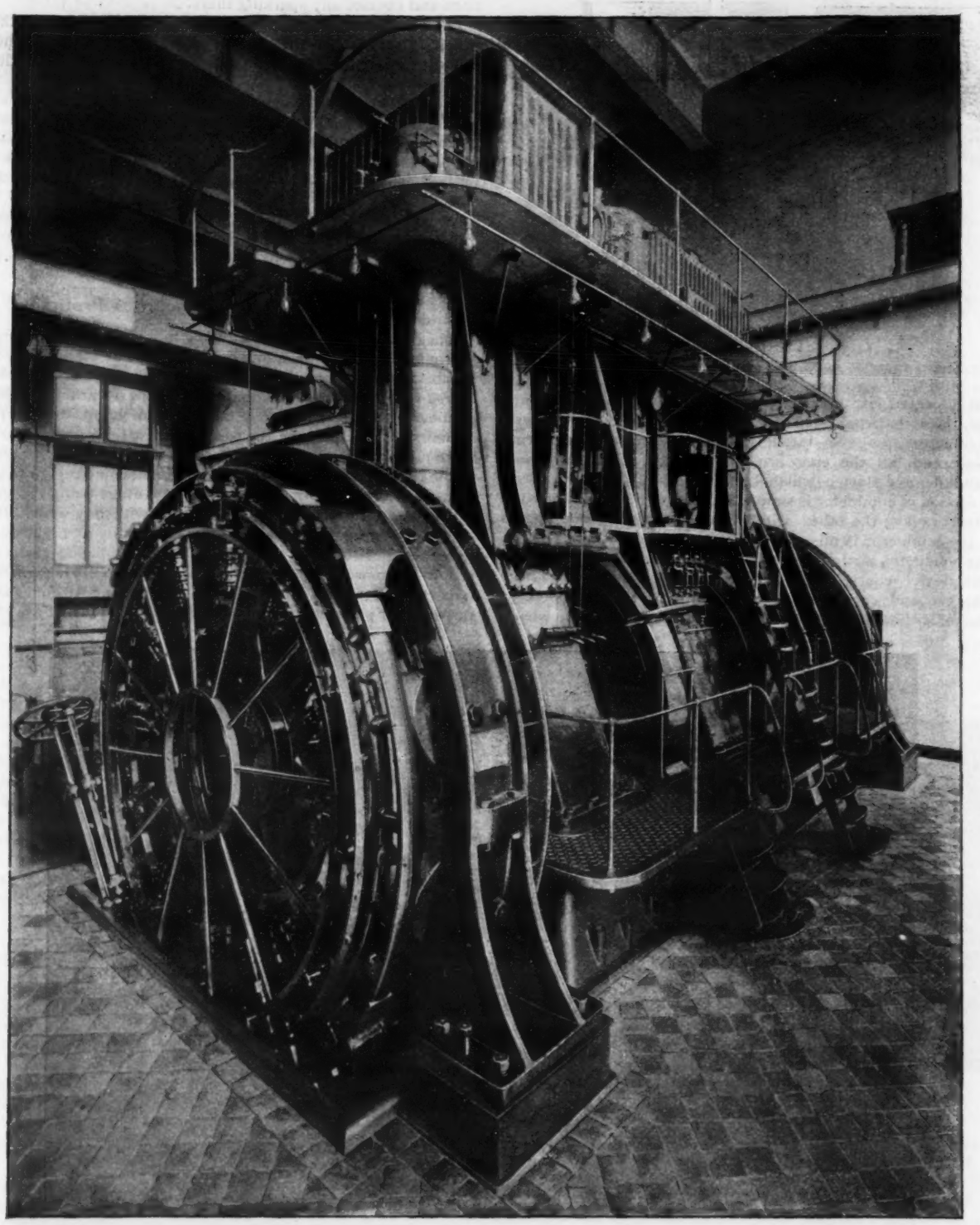
and now manufactures over a hundred different styles of lamps. The accompanying illustration gives an excellent idea of the brilliant appearance of the Bryan-Marsh factory at night.

A 400-Kw Direct-Connected Set.

The use of large generators direct-connected to the steam engine is now recognized as the standard practice in all the larger electric lighting stations. The great illuminating stations of New York, Boston, Chicago, Philadelphia, Brooklyn, St. Louis, San Francisco and elsewhere have discarded almost entirely the belt-driven generator in favor of the direct-connected machine. Space above the floor costs much less than floor space, and to this fact, as much as any other, is due the development and rapid adoption of the direct-connected generator.

The accompanying illustration shows a double 400-kw General Electric

The armatures, 100 inches in diameter, embody a recent development of the smooth-body type with reversible face commutator. This construction allows of the reversal of the armature on the shaft when the commutator on one side is worn to its limit, so that the brushes may be put into contact with the unworn side. The armature is a Gramme-ring, the core being built up of thin iron punchings and supported on a strong spider, keyed to the engine shaft. The windings are copper bars of large cross-section. The brush mechanism differs in many respects from that used with the older smooth-body armature generators. The large brush-holding spider is replaced by rings fastened to the frame, which have other rings sliding upon them and carrying the brushes. The brushes are controlled by two hand wheels, one of which shifts them upon the commutator, the other raises them from its face or brings them into contact with it simultaneously.



A 400-kw Direct-Connected Generating Combination.

combination recently set up in the Brooklyn Edison station. The machines are twelve-pole and were designed for an output of 2,960 amperes at a voltage of 135 when running at 120 revolutions per minute. The frames are of steel. Each generator occupies a floor space of 37 inches by [illegible] inches, and measures from the bottom of the supporting feet to the top of the frame 107 inches.

The weight of the armature is about 21,000 pounds, and that of the complete machine about 27 tons. Special precautions were taken in designing this class of generators to eliminate losses from eddy currents or from overheating. Machines of this type are running in numerous stations throughout the country with a success which demonstrates the perfection of their design and the care with which they were built.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Sept. 28, 1895.

AMERICAN BELL manifested some increase in strength upon the publication on Wednesday of the company's output report for the month ended Sept. 20, which shows a net output of 12,659 instruments—the largest in the history of the company. The advance was not sustained, however, the stock coming back to-day to last week's closing figure. The executive committee of the company has voted to sell by auction on Oct. 29 the stock unsubscribed for by stockholders, amounting to about 6,000 shares.

ELECTRIC STORAGE is on a decided boom. The recent acquisition by this company of the control of the Tudor patents affected the stock in a way that is said to have surprised even the insiders.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	98	100
" " " Brooklyn	100	110	115
" " " Boston	100	..	152
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	54½	55
General Electric	100	38⅝	39
General Electric, pref	100	69	70
Westinghouse Consolidated, com	50	35¾	36
" " pref	50	55	..

BONDS.

Edison Electric Ill., New York	105	105½	105½
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	..	90¼

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	200	..
American District Telegraph	100	35	40
American Telegraph & Cable	100	93	96
Central & South American Telegraph	100	117	120
Commercial Cables	100	150	..
†Erie Telephone	100	..	64
Gold & Stock Telegraph	100	105	..
New England Telephone	100	90	..
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63½	..
Western Union Telegraph	100	92¼	92⅜

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	18½	19
Binghamton RR. com	100	100	..
Brooklyn Traction	100	13	15
" " pref	100	61	64
Buffalo St. Ry	100	84	86
Cleveland City Ry	100	69	70
Cleveland Electric Ry	100	50	60
Columbus St. Ry	100	54	56
Consolidated Traction of N. J	..	25	..
Electric Traction, Philadelphia	50	70½	71
Hestonville	100	56	58
Long Island Traction, all pd	100	20¼	21
Louisville St. Ry. com	100	37	39
" " " pref	100	87	88
New Orleans Traction	100	21	23
" " pref	100	70	73
North Shore Traction	100	34	36
" " pref	100	84	86
People's Traction $30 pd	25	64¼	64½
Philadelphia Traction	50	81½	82½
Rochester St. Ry	..	..	39
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	73½	73¾
" " pref	100	93	94
Worcester Traction	100	18	19
" " pref	100	88	90

BONDS.

Buffalo St. Ry. 1st con. 5s	100	108	109
*Binghamton Railway Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s	100	101	103
Rochester St. Ry. 1st 5s	100	105½	106½
*Union Ry. 1st mtge 6s	100	105	108
*Westchester Electric 1st mtge 5s	100	98	101

* With accrued interest.
† Ex-Div.

THE TRACTIONS.—Columbus Street Railway (Ohio) stock, after a decline of about a point and a half, during which very little changed hands, rallied slightly and closed strong and in better demand. The bonds, however, after recent sales at 103¼ and interest, can now be bought considerably below that figure. The publication of the August earnings of the New Orleans Traction Company did not have any appreciable effect on the price of the securities, although the report was very favorable. The gross earnings for the month were $113,316, a gain of $39,826, while the net earnings amounted to $39,519, against $22,250 a year ago, a gain of $17,269. The unfavorable report of the Atlantic Avenue Railway (which is controlled by the Brooklyn Traction Company) for the year ending June 30 is due principally to the strike of their employees last Winter, the effect of which, as the reports of the past few months show, has about worn off. The net earnings for the year show a decrease of $183,299, while the fixed charges increased $49,865, leaving a deficit of $91,709, against a surplus of $115,226 last year. The quotations for the securities of the Brooklyn Traction Company, however, have not changed materially. The rest of the list has declined fractionally, with the exception of the stocks of the Worcester Traction Company and the Steinway Railway Company.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Sept. 30, 1895.

PROGRESSIVE RAILWAY MANAGEMENT.—The Brooklyn Heights Railway Company has appointed about 50 inspectors to look after the passengers, and see that motormen and conductors discharge their duties properly. The up-to-date management of this road has elicited considerable favorable comment. The company has completed arrangements to operate a trolley line from Fulton Ferry to Jamaica without change of cars for a fare of 10 cents.

RECEIVER FOR THE UNITED STATES ELECTRIC FORGING COMPANY.—George Putnam Smith has been appointed by Judge Barrett, of the Supreme Court, receiver of the United States Electric Forging Company, of 40 Wall Street, in a suit brought by George D. Burton, of Boston. The company was incorporated in July, 1894, with a capital stock of $1,000,000, under West Virginia laws.

TO PAINT EUROPE.—Owing to the increased demand for "P. & B." products abroad, it has become necessary for the Standard Paint Company, of 2 Liberty Street, to establish headquarters of its own in England, and to that end President Shainwald sailed from here via the *St. Louis* on Wednesday, Sept. 25. Mr. Shainwald contemplates spending two or three months abroad and expects to establish agencies for the sale of "P. & B." products in all the principal foreign cities.

MR. JOHN C. BOSS, of the Lakon Company, of Elkhart, Ind., is visiting New York this week with his wife, and has been kept busy receiving the congratulations of his numerous friends. Notice of Mr. Boss's marriage in Elkhart appeared in the last issue of THE ELECTRICAL WORLD. The ceremony was attended by a number of representatives of electrical interests, among them being Mr. and Mrs. F. S. Terry, of Chicago. Mr. and Mrs. Boss will remain in the East for a week or more.

SHEEPSHEAD BAY LINE OPENED.—The Nassau Electric Railway Company at a late hour on Thursday night completed the laying of the tracks for its Sheepshead Bay line over the Long Island tracks at the crossing at Ocean Avenue, Brooklyn, although some hours previous the Long Island Railway Company had secured a temporary injunction from Justice Pratt. When the matter came before the court the latter company withdrew its objections, with the understanding that the Nassau Company would place three flagmen at the crossing to prevent a possible collision between the trolley cars and the Manhattan Beach trains. The Nassau Company agreed to this proposition, and this ended the fight between the rival companies.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, of 32 Cortlandt Street, has issued the third edition of its special catalogue of telephones and other specialties. The company now manufactures three styles of battery telephone outfits and three of magneto outfits, and furnishes complete outfits or any parts thereof as may be desired. The Manhattan Company states that nearly half a million of its widely-known "Mesco" dry batteries have been sold, which is strong evidence of the worth of the battery as well as of the manufacturing facilities of the company. It is difficult to realize that this progressive concern, now standing in the front ranks of supply dealers and manufacturers of specialties, started in business a comparatively few years ago with a capital of $1,000. Its substantial success has been entirely due to excellent management and unremitting attention to every business detail.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., Sept. 28, 1895.

THE SHAWMUT FUSE WIRE COMPANY has removed to more central and spacious quarters at 93 Federal Street, where Mr. Chas. Garrison, its general manager, will be pleased to welcome old and new friends.

THE ÆTNA ELECTRIC COMPANY, of Hartford, Conn., recently incorporated under the laws of West Virginia, succeeds the Ætna Electric Works in the manufacture and sale of incandescent lamps, Mr. Henry Green and Mr. Chas. F. Reinmann continuing with the new company, who, with Mr. Geo. S. Miller and Mr. Arthur E. Howard, all of Hartford, are its promoters.

THE MCNUTT INCANDESCENT LAMP is now being handled exclusively in New England by the Thompson-Brown Electric Company, of Boston

Mr. H. N. West acting with this company as general agent for the sale of their well-known lamps Mr. West is a "hustler," and is remarkably successful in making new customers and holding well the old ones. He reports excellent sales this month.

LINTON & SOUTHWICK, of Worcester, Mass., the well-known switch manufacturers, have opened a Boston office at the office of the Shawmut Fuse Wire Company, 93 Federal Street, which is a move in the right direction. Its Worcester factory has, for some time, been kept very busy in filling orders, rendering necessary an increase of working force and the running of the factory up to 10 o'clock at night.

THE EDDY ELECTRIC MANUFACTURING COMPANY, of Windsor, Conn., has appointed as its Western agents J. B. Wallace and W. S. Hine, with headquarters at 305 Dearborn Street, Chicago. The Eddy Company possesses now an excellent agency corps, its business has increased wonderfully, and still continues to increase beyond even the most sanguine expectations of its popular and able management.

THE AMERICAN WHEELOCK ENGINE COMPANY'S WORKS, at Worcester, Mass., is a perfect beehive of activity at the present time, being taxed to its utmost capacity up to 9 o'clock at night, and we are informed by Assistant General Manager Charles Clough Hardy that the Philadelphia and Milwaukee works are equally busy. But few companies can boast of so strong an executive management as can this company. As is now quite well known Mr. Edwin S. Cramp, of Philadelphia, Mr. J. H. Hoadley, of Hoadley Brothers, the well-known engineers of Chicago, Ill., and Mr. E. K. Hill are its permanent officials, and the company represents the consolidation of several important engine patents and interests.

THE COLUMBIA ELECTRIC COMPANY, of Worcester, Mass., has been awarded the contract for the new plant of the Worcester Corset Company, now in process of construction in that city. The dynamo is to be a 1,000-light direct-connected multipolar, and we believe is the first of its kind contracted for in New England. This contract was awarded to the Columbia Company after investigating, through an electrical engineer, the merits of the different machines and bids submitted. The contract includes the wiring for the above number of lights, together with dynamo and fixtures. The Columbia Company has also received from the Joslyn House, Worcester, a contract for the wiring for its new electric lighting plant as well as the installation of a 40-drop annunciator. It has also contracted with the Warren Thread Company, of Ashland, Mass., for a plant of two dynamos and the wiring for 400 lights. Altogether the Columbia Company is doing an excellent business, which has unquestionably been brought about through several creditable electrical installations in and around Worcester, notably, and the more recent, the plant in the American Wheelock Engine Company's works, which required to be put in and running within seven days, and which was successfully accomplished, notwithstanding it was overrun with work at the time.

Western Notes.

Branch Office of The Electrical World,
936 Monadnock Building,
Chicago, Ill., Sept. 26, 1895.

THE BOUDREAUX DYNAMO BRUSH COMPANY reports a steadily increasing business all over the country. The Robinson Engineering Company, of Baltimore, has been appointed sole agent for Maryland, Virginia and the District of Columbia.

MR. R. LEO VAN DER NAILLEN has been obliged to resign his position as Western manager for the Boudreaux Dynamo Brush Company, and return to California on account of the illness of his wife. All who have had occasion to come in touch with him during his stay in Chicago will certainly regret his departure, and especially its cause.

MR. C. J. O'HARA, secretary of the Austin Separator Company, Detroit, Mich., who has been spending a well-earned vacation in the wilds of Rhode Island, has abandoned rubber boots, rod and gun and returned to Detroit, in better trim than ever before to demonstrate the merits of the Austin Separator. Mr. O'Hara reports that the business being done by his company at present is entirely satisfactory, new orders coming in from all parts of the country and second orders and merited testimonials being received from former purchasers.

THF PUMPELLY-SORLEY BATTERY STORAGE COMPANY is pushing ahead with little commotion but a vast deal of energy and excellent business management. Among other contracts recently closed are the following: Chicago Board of Trade, 60 1600-ampere-hour cells, to be used in conjunction with the new electric lighting plant and electric elevators; Hotel Ashland, 56 140-ampere-hour cells to operate electric elevator from 7 a. m. until 4 p. m; Sunbeam Incandescent Lamp Company, 30 150-ampere-hour cells for testing lamps in the factory; St. Joseph & Benton Harbor Electric Railway Light & Power Company, St. Joseph, Mich., 240 200-ampere-hour cells to be used as an auxiliary in the railway and lighting station. This latter plant will be the first installation of storage batteries in conjunction with an electric railway plant in the United States.

Canadian Notes.

Ottawa, Sept. 26, 1895.

GUELPH, ONT.—The Electric Street Railway in this city was formally opened on the 17th inst., and is now in full working order.

MONTREAL, QUE.—Messrs. Mills, Leamy & Murphy are pushing work ahead on their contract on the Electric Belt line, one mile now being graded.

HALIFAX, N. S.—The Halifax Electric Railway Company have ordered two 300-hp Robb-Armstrong engines in addition to two of the same kind now under construction.

SHERBROOKE, QUE.—The Sherbrooke Electric Railway Company is applying to the legislature for a charter to construct and operate an electric street railway in Sherbrooke.

OTTAWA, ONT.—A few capitalists are looking into the possibility of forming a company to build an electric railway, to run from Ottawa to Morrisburg, via Eastmans Springs and Chesterville.

TORONTO, ONT.—The Electric Street Railway Company have constructed four special cars for handling big crowds. Each is equipped with a powerful motor capable of drawing a train of six trailers.

QUEBEC, QUE.—Negotiations are in progress between H. J. Beemer and the Montmorency Electric Power Company for the purchase of all the latter's property and rights. It is said that it is this deal that has delayed the construction of Quebec's electric street railway.

HAMILTON, ONT.—The Hamilton Radial Railway is making application to the City Council for free right of way on Cannon Street for the electric road from Majora Falls to Toronto. The directors say all they want from the corporation is this right of way but no bonus. It is stated that the Hamilton Company has closed a contract with the Niagara Power Company which makes the construction of the road a certainty. The company has abandoned the steam railway part of the enterprise and will build an electric road. It is asking the city for right of way along Sherman Avenue also.

MONTREAL, QUE.—Manager Cunningham, of the Electric Street Railway, when asked why the electric lights in the street cars were kept burning during the day in a thunderstorm, said the lights act as a lightning arrester, and should the lightning strike the wire it would take the path of the lamp circuit and not enter the car.

BROCKVILLE, ONT.—The Brockville Electric Railway, with a capital of $200,000, are applying to the Ontario Government for a charter to construct and operate a line of electric railway in the town of Brockville and in the township of Elizabethtown, Leeds County. The applicants for the charter are W. H. Combstock, C. S. Cossitt, D. S. Booth, O. K. Fraser, G. I. Mallory, W. A. Galinour and M. M. Brown, all of the town of Brockville.

ST. THOMAS, ONT.—The fire and light committee have recommended to the Council the acceptance of the tender of the Electric Street Railway Company to light the streets of the city for eight years, from January, 1896, with 90 electric arc lights, 2,000 cp, at 25½ cents per lamp per night. The annual cost of lighting under this scheme (on a moonlight schedule of 305 nights) will be $7,000. The present cost of 31 electric lamps, 1,200 cp, and 98 gas lamps, 18 $5,226, and the cost of their continuance under a proposal from the gas company for a renewal of their contract would be $3,820.

English Notes.

[FROM OUR OWN CORRESPONDENT.]

London, Sept. 18, 1895.

ELECTRIC TRACTION.—The electric line on the overhead trolley system now being equipped for Bristol by the British Thomson-Houston Company, is approaching completion.

LONG-DISTANCE TELEPHONY.—What may be called international telephonic communication is making rapid progress on the Continent. Brussels will shortly be placed in communication with Cologne on the one hand and with the Dutch capital on the other. As it is already in telephonic communication with Paris, it will be possible, before long, to telephone from Paris to The Hague.

ELECTRICITY IN THE NAVY.—Some few years ago the fine second-class battleship *Barfleur* was fitted with electric motors in connection with the training and elevating gear of her big guns. Experience of the use of electric motors for this purpose has proved so satisfactory that the admiralty have now ordered electric gearing for the ammunition hoists of the battleships *Centurion* and *Renown*. The 12-inch guns on board the new first-class battleships *Cæsar* and *Illustrious* are also to be fitted with electrically-driven training and elevating gear.

ELECTRIC TRACTION IN GLASGOW.—A little more than a year ago the Glasgow Town Council took over the tramway system of that city, the purchase price being £400,000. About a year previous to the purchase there was considerable discussion as to whether or not some form of mechanical traction should be substituted for horse traction, and it was finally decided that no form of mechanical traction offered sufficient advantages to warrant the additional outlay that would have to be incurred. Now, however, that they have had experience of horse traction, the Town Council would appear to have been worked into a different frame of mind, and a special committee has been appointed to inquire into the possibilities of the overhead trolley system.

General News.

New Incorporations.

THE CITIZENS' ELECTRIC COMPANY, Williamsport, Pa., has been incorporated to supply electric light, heat and power, by Grant Sweet and C H. Hill, Williamsport, Pa., and Ray R. Sweet, Canton, Pa. Capital stock, $2,000.

THE SHARON ELECTRIC COMPANY, Sharon, Conn., has been incorporated to manufacture, generate and produce and lease electricity, etc. Those interested in the project are I. N. Bartram, Agt., E. C. Gillette, C. C. Gordon, Sharon, Conn. Capital stock $10,000.

THE HUNTINGTON GAS COMPANY, Huntington, L. I., N. Y., capital stock $60,000, has been incorporated for the purpose of supplying gas and electricity. The promoters are L. B. Gleason, W. B. Hord, New York City and Victor Cumberson, Brooklyn, N. Y.

THE BLOCK LIGHT, HEAT & POWER COMPANY, Denver, Col., capital stock $25,000, has been formed for the purpose of furnishing light, heat and power for blocks and buildings in Denver. The incorporators are William J. Barker, John H. Poole, A. E. Grier, Denver, Col.

THE NORTH NEW YORK CITY TRACTION COMPANY, New York City, N. Y., capital stock $210,000, has been formed to build and operate a street surface road in New York City. The promoters are Henry Seibert, J. H. Haskin, W. T. Ryan, E. J. Goldrick, New York City.

THE NEWTON ELECTRIC COMPANY, Newton, Iowa, has been organized for the purpose of manufacturing, generating and furnishing electricity for light, heat and power. B. F. Sunny, James S. Cumming, Chicago, Ill., and H. M. Vaughan, Newton, Iowa. Capital stock $25,000.

THE HOLMES & BASSETT COMPANY, Waterbury, Conn., has been formed to manufacture and deal in curtain fixtures, electrical appliances, etc. The promoters are Walter W. Holmes, Charles L. Holmes, Waterbury, Conn.; Fred H. Bassett, Saranac Lake, N. Y. Capital stock $20,000.

THE ULSTER COUNTY ELECTRIC RAILWAY COMPANY, Kingston, N. Y., capital stock $100,000, has been formed for the purpose of building and operating an electric street railway. The promoters are C. A. Johnson, W. T. Tiers, F. H. Reed, G. N. Kibbin, all of New York City.

THE GRIER-YOUNG ELECTRIC COMPANY, Camden, N. J., capital stock $10,000, has been incorporated to manufacture electrical supplies and appliances. The promoters are Alfred S. Hottle, Harry G. Grier, Mahlon Young, Philadelphia, Pa., and Aaron T. Lovett, Camden, N. J.

THE OELWEIN ELECTRIC LIGHT & POWER COMPANY, Oelwein, Ia., capital stock $50,000, has been incorporated for the purpose of constructing and operating an electric light and power plant in Oelwein. The promoters are J. H. Kerwin, James Burlingett, D. McNab, A. C. Stevens, Oelwein, Ia.

THE NEW BRITAIN ELECTRIC CONSTRUCTION & SUPPLY COMPANY, New Britain, Conn., has been incorporated for the purpose of doing electrical construction work of all kinds. The promoters are Henry C. Williams, George W. Fiske, Harry Horner, New Britain, Conn. Capital stock $5,000.

THE COLUMBUS SCENIC RAILWAY COMPANY, Cincinnati, O., has been organized for the purpose of building and operating scenic railways, operating pleasure parks, halls, etc. The promoters are John J. Shipherd, M. H. Solloway, W. E. Hutton, J. M. Hutton, W. D. Hutton. Capital stock $15,000.

THE NEVADA ELECTRIC RAILWAY, LIGHT & POWER COMPANY, Nevada, Mo., has been organized for the purpose of operating street railways, and for furnishing electric light, heat and power. The incorporators are H. C. Moore, C. E Strohm, Nevada, Mo; G. W. Dudley, Upper Alton, Ill. Capital stock $130,000.

THE TOLEDO & PETERSBURGH ELECTRIC RAILWAY COMPANY, Toledo, O., capital stock $200,000, has been organized to build and operate an electric railway from West Toledo, O., to Petersburgh, Mich. The incorporators are John O. Zabel, Winfield S. Coon, Willis Baldwin, George F. Wells, Clyde E. Coon.

THE GATES ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., capital stock $25,000, has been formed to manufacture, sell and operate electric light plants, and manufacture and sell engines, boilers, machinery and all electrical appliances. The promoters are J. Holt Gates, William F. Camp, Jr., Adolf Lissan and D. V. Samuels.

THE FORT WAYNE & HICKSVILLE ELECTRIC RAILWAY, Fort Wayne, Ind., has been formed to construct, own and maintain a street railway in Fort Wayne. Those interested are John S. Hart, Hicksville, O.; James B. Colgrove, Washington, D. C.; John W. Winn, Defiance, O.; Aaron M. Richelderfer, Harlan, Ind. Capital stock $50,000.

THE GLOBE ELECTRIC COMPANY, Cleveland, Ohio, has been organized for the purpose of manufacturing, purchasing and dealing in electrical telephones and other electrical and magnetic apparatus, and for doing a general electrical business. The incorporators are C. E. Collins, J. W. Bradley, Donald McKenzie, T. W. Larwood, Jr., J. D. Barron. Capital stock $25,000.

THE JAMES D. GRAY STEAM ENGINE & MOTOR COMPANY, Baltimore, Md., has been incorporated in West Virginia for the purpose of manufacturing, purchasing and selling steam engines, electric motors, batteries, dynamos, etc. The promoters are P. V. Benson, M.D., B. Brent Walling, Ernest Sharp, William S. Taylor, Baltimore, Md. Capital stock, minimum $500; maximum, $1,000,000.

THE HUNTINGTON, COLUMBIA CITY & LIGONIER ELECTRIC RAILWAY COMPANY, Columbia City, Ind., has been organized to construct, maintain and operate electric street railways in the cities of Huntington, Columbia City, Albion and Ligonier. Those interested are Vallorous Brown, George W. Ruch, Joseph H. Ruch, Thomas R. Marshall and William F. McNagny. Capital stock, $50,000

THE WARWICK ELECTRIC MANUFACTURING COMPANY, Cleveland, Ohio, capital stock $20,000, has been incorporated for the purpose of manufacturing and dealing in storage batteries, dynamos, motors, arc lamps, electrical appliances, and erecting and maintaining isolated electric lighting plants. The promoters are P. B. Warwick, Daniel H. Ridgway, George F. Ridgway, Michael Phalen, C. N. Cunningham.

THE STANDARD STORAGE BATTERY COMPANY, New York, N. Y., has been incorporated in West Virginia, capital stock $500 minimum, maximum $1,000,000, to manufacture, use and sell storage and other batteries, electrical appliances, etc. Those interested are George H. Graham, East Orange, N. J.; Harry N. Low, New York City; J. Heron Crosman, New York City, and William H. Jewell, Brooklyn, N. Y.

THE MERCED FALLS ELECTRIC POWER & MANUFACTURING COMPANY, San Francisco, Cal., capital stock, $1,000,000, has been formed to distribute water for all purposes, develop and furnish water, construct electric plants and carry on a general manufacturing and merchandise business. The promoters are R. H. Duncan, Herman John, San Francisco; J. T. Fleming, Augustus Laver, Alameda, and Basil Owen, London, England.

THE ASBURY PARK, BRADLEY BEACH, BELMAR & SPRING LAKE STREET RAILWAY COMPANY, Bradley Beach, N. J., has been formed to construct, maintain and operate a street railway and to construct and operate motors, cables, etc. The promoters are Henry C. King, New York City; Alex. Bogy, Brooklyn; N. E. Buchanon, John Hubbard, Asbury Park, N. J., and Charles H. Seaman, Bradley Beach, N. J. Capital stock $75,000.

THE UNION TRACTION COMPANY OF PHILADELPHIA, Philadelphia, Pa., has been formed for the purpose of building and operating street railways to be operated by electricity or cable power. The incorporators are James McNanes, Peter A. B. Widener, William L. Elkins, Thomas Dolan, George D. Widener, Jeremiah J. Sullivan, Alfred Smith, Alex. M. Fox, John Lowber Welsh, William H. Shelmerdine, Caleb F. Fox, Philadelphia, Pa. Capital stock $100,000.

TELEGRAPH AND TELEPHONE.

ELIZABETHTOWN, PA.—A movement is in progress to establish a telephone exchange here.

WINONA, MINN.—It is understood that the Winona Telephone Company expects to extend its lines.

MANKATO, MINN.—The Northwestern Telephone Company has decided to extend its line to Lake Crystal.

BARNESVILLE, GA.—A telephone exchange is to be established. G. E. Hugeley, mayor, can probably furnish information.

SUPERIOR, WIS.—The city of Superior has granted the Northwestern Standard Telephone Company a 30-year franchise.

KALAMAZOO, MICH.—The Southern Michigan Telephone Company will extend its lines from Vicksburg to Schoolcraft and Kalamazoo.

OLIVET, IA.—George W. Williams has secured the right of way from the county commissioners to construct 100 miles of telephone lines.

UNION, ORE.—The County Court has granted the Grand Ronde Telephone Company permission to build a telephone line from Union to Elgin.

BEAUMONT, TEX.—The Beaumont Telephone Company will construct telephone lines and exchanges in Jefferson, Hardin and other counties.

PENN YAN, N. Y.—The Penn Yan Board of Trustees has decided to grant a franchise to W. S. Stanley Bruen to erect and operate a telephone system.

CARROLLTON, ILL.—S. E. Simpson and H. B. Kenny have made a proposition to the Council to operate an electric plant in connection with the water works.

ROCHESTER, N. Y.—The Standard Electric Telephone Company has asked the Common Council for a franchise to lay its wires through the streets of Rochester.

CHARLESTON, S. C.—The Carolina Mutual Telephone & Telegraph Company will establish a new telephone system in Charleston. E. M. Bailey is interested.

KIRKWOOD, MO.—The Bell Telephone Company has been granted a special franchise by the Town Board to erect poles and wires for the new suburban lines.

LA GRANDE, ORE.—Local capitalists will build a telephone line from La Grande to Union and Elgin. J. W. Scribner, F. D. McCully and W. W. Hinman are interested.

LOUISIANA, MO.—The Louisiana Telephone Company is making arrangements to extend its system through all the towns along the line of the Chicago & Alton Railway to Mexico, Audrian County.

NEWARK, N. J.—Permission has been asked of the Board of Public Works by the Newark Telephone Company, to lay telephone wires and conduits in certain streets, and to string overhead wires in other streets.

PEADODY, MASS.—At a recent meeting of Selectmen, it was voted to grant the telephone company right of way for a new line to Salem, providing the company establishes a direct line between Peabody and Boston.

ROME, GA.—A telephone line is projected from Center, the county seat of Cherokee County, Alabama, to Gadsden, about 30 miles. Parties along the line of the Rome & Decatur Railway are anxious to secure a line between Rome and Gadsden.

BALTIMORE, MD.—An ordinance, granting permission to the Standard Telephone Company, of Washington and Baltimore, to erect telephone and telegraph wires in the streets, was offered by Mr. Minifie at a recent meeting of the Council.

VERMILLION, S. D.—The City Council met in regular session and an ordinance passed its first reading granting a franchise to J. C. Tomlinson, W. A. Cottrell and the Clark Electric Telephone Company, to put in a system of telephones at Vermillion.

SOMERFIELD, PA.—The Somerfield Telephone Company has received its charter to construct and operate a line connecting Petersburg, Markleysburg, Confluence, Uniontown, and other towns in Somerset and Fayette Counties. M. R. Thomas, of Markleysburg, is president.

ALICE, TEX.—The Alice, Wade City & Corpus Christi Telephone Company has received its charter for constructing and maintaining a line in and through the counties of Cameron, Hidalgo, Neuces and other counties. George Hobbs, Thomas C. Wright and John Wade are interested.

BOULDER, COL.—The Mexican Industrial Railway Company will construct telephone and telegraph lines and electric railways from the City of Mexico in various directions. Benjamin T. Cheney, of Boston, Mass.; Stephen W. Reynolds and Walter S. Wait, of Newton, Mass.; James H. George, of Plaiston, N. H., and Arthur P. Cushing, of Boston, are interested.

HUNTSVILLE, TEX.—The parties interested in the Huntsville-Madisonville telephone line have organized under the style of the Commercial Tele-

phone Company, and will build to Madisonville and Midway. J. F. Randolph and J. R. Burtis, of Madisonville; F. L. Young, of Midway; R. S. Rather, C. G. Barrett, L. C. Eastham, and J. G. Ashford, of Huntsville, are directors.

Electric Light and Power.

ELORA, IND.—John West has a project on foot to establish an electric light plant.

CHARDRON, O.—The citizens are considering the matter of putting in an electric light system.

HUBBARD, O.—The citizens have voted to insure $6,000 in bonds to put in an electric light plant.

NEW ORLEANS, LA.—The Council has adopted the ordinance for placing electric wires underground.

COTTONWOOD, IDAHO.—Samuel Dunham, of the cotton packing company, expects to build an electric plant.

ATHENS, GA.—An election will be held Oct. 26 to determine the question of issuing bonds for an electric light plant.

LYNDONVILLE, VT.—At a special village meeting, recently held, it was voted to put in and operate an electric light plant at once.

SCRANTON, PA.—The proposition of the Board of Trade of West Scranton to establish an electric light plant is meeting with encouragement.

HAMMOND, LA.—The Hammond Electric Light & Power Company is making preparations for erecting its electric light and power plant.

PRINCETON, ILL.—The Princeton Electric Company has been placed in the hands of a receiver. The liabilities are about $34,000 and assets $11,000.

FORT ATKINSON, WIS.—The proposition to issue $30,000 for an electric light and water works plant was defeated at the recent special election by a vote of 364 to 159.

BLOOMFIELD, N. J.—John P. Conklin has made a proposition to the Council's committee of Bloomfield to erect an electric lighting plant in the town and furnish arc lights of 2,000 cp.

LE SUEUR, MINN.—The electric light question is being vigorously pressed, and a special election will be held soon to determine whether or not the city shall issue bonds for the purpose of building a plant.

NORWOOD, O.—The Board of Water Trustees will receive bids until Oct. 19 for furnishing material and labor required to build and equip an electric light plant. Henry Rikhoff, Herman Erdman, Edward C. Toage constitute the board.

EAST MAUCH CHUNK (MAUCH CHUNK) PA.—The proposed borough electric light plant and the electric road extension are now under consideration of the Town Council of East Mauch Chunk. The estimated cost of the electric light plant is $12,500.

NEW YORK CITY.—Architect Edward Wenz, 205 East Eighty-fourth Street, will draw plans and prepare specifications for a row of apartment houses to be erected by McNeil & Taylor on the south side of 116th Street, east of Seventh Avenue, to be wired for lights and bells.

PITTSBURG, PA.—Sealed proposals for combination gas and electric fixtures for the Fifth Avenue High School Building will be received at the office of the secretary of the Central Board of Education, 516 Market Street, until noon Oct. 7. Further information can be had from Edward Stotz, architect, 101 Fifth Avenue.

ST. PAUL, MINN.—At a meeting of the Board of Aldermen, Alderman Brady introduced a resolution authorizing the city clerk to advertise for bids for lighting the down-town district with arc lights of 2,000 cp each, one lamp to be placed at each street intersection. The contract is to become operative on April 1, 1896, and continue for one year.

The Electric Railway.

MEADVILLE, PA.—Meadville is desirous of having an electric street railway.

CAMDEN, ME.—It is proposed to extend the electric road to Belfast next year.

ALLENTOWN, PA.—The Traction Company's lines will be extended to Hellertown.

CHARLESTON, S. C.—It is proposed to construct an electric road from Charleston to Somerville.

TANNERSVILLE, N. Y.—The construction of an electric road from Otis to Tannersville is contemplated.

FARGO, N. D.—G. N. Nickells, of Wahpeton, is interested in a project to put an electric line in operation in Fargo.

NEW CASTLE, KY.—An electric railway between New Castle and Eminence, in Henry County, is talked of; estimated cost, $40,000.

HANSON, MASS.—The business men of Hanson are raising subscriptions for stock for an electric railway from Hanson to Whitman.

SCRANTON, PA.—The traction company officials have decided to extend the newly laid line on Franklin Avenue to Mulberry Street.

TIFFIN, O.—The horse car line of Tiffin has been purchased by Hatcher & Yeager, who will immediately put in electrical equipment.

MEADVILLE, PA.—The right of way for the proposed electric railway, from Edinboro, Erie County, to Cambridgeboro, has been secured.

WARREN, O.—The directors of the Trumbull Electric Railway Company have decided to begin work on the extension to West Warren.

BOSTON, MASS.—It is understood that the West End Street Railway Company intends to erect a power-house on land recently purchased.

BEDFORD CITY, VA.—C. R. Ruffin, of Charlottesville, has applied to the Council of Bedford City for a franchise to construct a street railway.

CHESTER, PA.—A trolley line will probably be built along the river road, from the Lazaretto to Philadelphia. Joseph H. Hinkson is interested.

HARRISBURG, PA.—The Cumberland Valley Traction Company is pushing the work on its lines to New Cumberland, Boiling Springs and Carlisle, Pa.

KANSAS CITY, MO.—B. Korman is seeking a franchise from the city to construct a street railway from the terminals of the electric line to Korman's Park.

SANDUSKY, O.—W. W. Graham, of Norwalk, and Charles Rude, of Sandusky, are promoters of a proposed electric road from Sandusky to Seven Mile House.

CAIRO, ILL.—An ordinance is before the Council for the granting of a franchise to E. W. Halliday to construct an electric railway on Syracuse Street.

DENVER, COL.—The West End Street Railway Company has under consideration the extension of its road to Golden. D. F. Longstreet is superintendent.

ERIE, PA.—An electric road on Parade Street, through Wesleyville to the Four Mile Creek, is talked of. Councilman Edward Mehler can probably give information.

AMSTERDAM, N. Y.—It is proposed to extend the Amsterdam street railway to Johnstown and Gloversville, and it is expected that work will be begun in the Spring.

BALTIMORE, MD.—The Columbia & Maryland Railway Company has made application for permission to lay a double or single track electric railway on Wilkins Avenue.

OMAHA, NEB.—The proposition to vote $13,000 in bonds to aid in the construction of a street railway line from Amos Avenue, this city, to Florence, was carried by a vote of 131 to 31.

OSWEGO, N.Y.—The directors of the Oswego Street Railway Company have increased the capital stock from $125,000 to $200,000, and extensive improvements will be made.

HUNTINGTON, IND.—The Huntington, Columbia City & Ligonier Electric Railway Company proposes to construct electric lines in the three cities mentioned in the company's name.

NORTH EASTON, MASS.—The franchise granting to the Brockton & North Boston Railway Company permission to lay their road in this town has been accepted by the officials of the road.

TACOMA, WASH.—Architect John D. Proctor has finished plans for remodeling and building the power-house of the Tacoma Railway & Motor Company. About $10,000 will be expended.

SCHUYLKILL HAVEN, PA.—The contract for the construction of a trolley line between Minersville, Sailorsville and Pottsville to Schuylkill Haven has been awarded to Thomas Connell, of Pottsville.

PHILADELPHIA, PA.—The officials of the People's Traction Company contemplate establishing an extensive park at Willow Grove, to which and through which the company's tracks will be laid.

MIDDLETOWN, MD.—At a recent meeting in Fredericksburg of the directors of the Fredericksburg & Middletown Electric Railway Company it was decided to begin at once on the construction of the road.

BALTIMORE, MD.—The county commissioners have agreed to extend, by six months, the time for the commencement of the construction of the Mt. Washington electric road, of which George R. Webb is president.

BINGHAMTON, N. Y.—A company of capitalists has offered to pay $5,000 per mile for a franchise to construct and operate an electric railway, 12 miles long, in competition with the Scranton Traction Company's roads.

SPRINGFIELD, MASS.—The Selectmen of West Springfield have received a petition from President Olmstead, acting in behalf of the Springfield Street Railway Company, asking that a location be fixed on Park Street.

LEROY, N. Y.—The board of directors of the Leroy & Northern Railway Company have petitioned the Board of Trustees for permission to build and maintain a single line of railway track upon the highways in the village.

UTICA, N. Y.—An application has been made to the Common Council by the Utica Belt Line Street Railway Company for permission to construct extensions to its present street surface railway on various streets of the city.

MONTCLAIR, N. J.—The North Jersey Street Railway Company has presented a petition to the Council of Montclair asking for permission to construct, operate and maintain a single-track street railway on Elm and other streets.

HAVERSTRAW, N. Y.—A. A. Forman, president of the Haverstraw Gas Company, is the prime mover in a scheme to connect Haverstraw and Garnerville with a trolley road to be eventually extended to Stony Point and Tompkins Cove.

ALLEGHENY, PA.—At a meeting of the corporation's committee of Allegheny Councils, a resolution granting the Pleasant Valley Company the right to construct a line up Charles Street from Irwin Avenue to Perrysville Avenue, was read.

CARTHAGE, N. Y.—It is stated that the Central Railway Company has abandoned the idea of building a branch from Carthage to Copenhagen, and the feasibility of an electric road between these places is again under discussion by foreign capitalists.

ALBERT LEA, MINN.—George C. Edwards, of Bridgeport, Conn., has been in this city negotiating for the putting in of a line of street cars to run in connection with the electric light plant, if an exclusive franchise for a long enough number of years can be secured.

PITTSBURG, PA.—The contract for the building of the Knoxville, Fair Haven & Mt Lebanon Street Railway has been let to J. J. Houghton, of Allegheny, at $161,000. The new line will be operated by the Pittsburg & Birmingham Traction Company, of which Henry Meuschke is president.

URBANA, O.—The City Council has modified the ordinance granting the franchise to W. H. Hanford & Co., to build an interurban electric railway between Urbana and Springfield, to conform to their wishes. The promoters will undoubtedly accept the franchise as amended.

PELHAMVILLE, N. Y.—The citizens of Pelhamville are circulating a petition for signatures, to be presented to the Union Electric Railway, asking that corporation to extend its line from Third Street, Mount Vernon, to Pelhamville. It is thought that the company will extend the line.

LANSDOWNE, PA.—Application has been made to Lansdowne Borough Council for right of way through several streets for a trolley line, to be known as the Suburban Railway Company. The road is to be built from Philadelphia to West Chester, through Cardington, along the Marshall roads, then along Darby Creek to Tuscarora and Heyville and on to West Chester.

PHILADELPHIA, PA.—The trolley ordinance of the Grand Boulevard Street Railway Company came up before the Council's street railway committee last week and was referred to a sub-committee for investigation. The bill authorizing the Lehigh Avenue Passenger Railway Company to lay a double track on Glenwood Avenue, from Seventeenth Street to Lamb Tavern road, was also referred to a sub-committee.

CHICAGO, ILL.—The Chicago City Railway is completing the renewal of tracks on its Indiana Avenue line from Thirty-ninth Street south to Fifty-first Street. The old rails have been replaced by rails used in electric service, it being the intention of the company to equip the road with the trolley system. At the main offices it is said that the work of stringing wires might not be commenced this year, nor had it been settled whether the line would be extended beyond its present southern terminus.

MIDDLETOWN, CONN.—The Middletown Street Railway Company, of which Israel A. Kelsey, of West Haven, is a leading official, has obtained the permission to extend its lines to Cromwell, and work of construction will be started at once. The extension is to be three miles long and about $40,000 will be expended on the work. Boston & Maine Railway standard rails are to be used, and the overhead equipment is to be very heavy and substantial. Contracts for the construction will be let in a few days, and it is expected the road will be in operation before Winter sets in.

PERSONAL NOTES.

DR. JOHN HOPKINSON, of London, arrived at Montreal on Sept. 28, and will spend some time in the United States before returning to England.

MR. W. E. KEILY, of the *Western Electrician*, was married to Miss Catherine Meagher at Chicago, on Sept. 21. The many acquaintances in the electrical fraternity of Mr. Keily will join us, we feel sure, in wishing the happy couple many joyful years of connubial bliss.

DR. FREDERICK BEDELL, of Cornell University, arrived in New York on Saturday, Sept. 28, having returned from a several months' stay in Europe. Dr. Bedell attended the meeting of the British Association at Ipswich, and had the honor of being invited to sit with the committee on magnetic units, among whose members were Kelvin, Rayleigh, Ayrton, S. P. Thompson, Lodge and Everett.

MISCELLANEOUS NOTE.

THE CORRESPONDENCE SCHOOL OF TECHNOLOGY.—The incorporation of the Correspondence School of Technology, Cleveland, O., has been consummated, with Prof. E. P. Roberts as president; Thomas Robinson, treasurer, and J. C. Gallup, secretary. The school is in better condition than ever before, financially and otherwise, two courses and two instructors having been added. The courses taught by the school are, (1) Electrical Engineering, (2) Steam Engineering, (3) Bridge and Roof Construction, etc., (4) Civil Engineering, (5) Mechanical Engineering, (6) Hydraulic Engineering, and (7) Higher Mathematics.

Trade and Industrial Notes.

THE DIAMOND MACHINE COMPANY, of Providence, R. I., reports the receipt of a very large order for its patent lever and screw-feed lathes to go to a manual training school in California. These lathes are of the type furnished the Leland Stanford University about two years ago.

THE NEW YORK & OHIO COMPANY, of Warren, O., has published in pamphlet form the test of Packard lamps, made on June 20 by Prof. Thomas; the test was an exhaustive one, and the results were most flattering. Tables and curves are given, which show at a glance the performance of the lamps. The pamphlet is of much interest to central-station men and others using incandescent lamps, and may be had for the asking.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, of Hartford, Conn., has just issued a neat and handsome catalogue, in which is presented most tastefully the various styles of the Waterhouse, Gamble & Co. arc lamp, controlled and manufactured by it, as well as the principal and important features of the lamp, together with price list and valuable testimonials. The Perkins Company reports a large increased business in the sales of this well-known lamp, and with an extraordinary demand for its incandescent lamps, switches and sockets, its factory is employed to its fullest capacity.

CHAS. WIRT, "Dynamo Doctor," Philadelphia, is getting ready for the public an attractive pamphlet containing the opinions of some who were fortunate enough to make use of his prescription. One of these "opinions" came from Mr. M. A. Beal, secretary of the Forest City Electric Light & Power Company, Rockford, Ill., and reads as follows: "We have used your brushes exclusively during the past three years on our incandescent dynamos in central-station work. Since their adoption, we have had practically no repairs to make on commutators and absolutely no sparking at brushes under any load, or under changes of load. We consider them the most desirable brushes that we have ever used." Further comment would appear superfluous.

THE LARGEST ELECTRICAL PUMPING PLANT IN THE WORLD.—The Keystone Electric Company, of Erie, Pa., feels much gratified, and justly so, over the closing of a contract for the electrical portion of a huge pumping plant at the works of the Apollo Iron & Steel Company. It is said that the pumps will deliver 17,000,000 gallons per day, and the plant will be the largest one ever installed in which electric motors are used for driving the pumps. The electrical equipment will comprise two 35-hp and three 50-hp motors. The success of the Keystone Company in securing such a contract in the face of keen competition from larger concerns reflects great credit upon the business management, and is an infallible indication of the merits of the company's apparatus.

ALWAYS TRIUMPHANT, by virtue of its name and the marked success of its apparatus, the Triumph Electric Company, of Cincinnati, reports its factory some weeks behind orders on many standard sizes of dynamos and motors, while it has been entirely unable to keep up with the orders for the new "Triumph" multipolar elevator motor and automatic controller. Four of the company's new type multipolar generators have been recently sold in Chicago, and two 65-kw direct-connected machines are now being installed in a large shoe factory in Cincinnati. At the Atlanta Exposition the Triumph Company's machines are extensively in evidence, 12 being in practical use in the exposition machinery department, besides an attractive exhibit in Electricity Building, over which Mr. E. F. Seixas presides in a manner that has already made itself manifest by a very material increase in business from that section of the Cotton States.

SEVENTEEN YEARS certainly should be an ample period in which to determine the merits of arc light machinery, and if one judges by the quantity of arc apparatus installed during the past 17 years by the Brush Electric Company, of Cleveland, O., this question has been decided by the electrical public in a way that cannot fail to gratify the manufacturers. In an artistic pamphlet, entitled "Seventeen Years' Use of Brush Arc Apparatus," the Brush Company gives a brief summary of its operations and successes in the line of work indicated, and presents an extensive list of testimonial letters from Brush patrons of long standing. The introductory paragraph contains the significant statement: "The setting of the sun is followed by the starting of Brush arc lights in every country. One or the other is always shedding light on all civilized nations." The character of the testimonials is striking, one stating: "The (Brush) apparatus assists us largely in paying dividends:" another: "Our total repairs for five years on dynamos aggregating 250 lamps' capacity, running every night, have been $21, outside of commutator segments and brushes." One writer sententiously states: "We have a spare armature for a 60-light machine that has been waiting four years for a job." The pamphlet also contains a number of handsome illustrations of Brush arc lamps and dynamos, and a table giving full data concerning the various sizes of arc machines now built, which number about a dozen. A large number of the new 125-light arc machines have been sold, 14 having been placed in Cleveland alone and 12 in Newark, N. J.

Business Notices.

ELECTRIC LEAGUE.—Meets every Thursday evening, 100 West 24th Street, New York. Electrical engineers and electricians cordially invited.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 15 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED SEPT. 24, 1895.
(In charge of Wm. A. Rosenbaum, 177 Times Building, New York City.)

546,666. MEANS FOR VARYING LIGHT OF INCANDESCENT ELECTRIC LAMPS; C. A. Hussey, New York, N. Y. App. filed Sept. 29, 1893. A row of contact points inserted in the socket of a lamp and adapted to vary the brilliancy of the light, by means of through proper resistances.

546,689. ELECTRIC ARC LAMP; C. Weber, F. Roellner and A. Schweitzer, Allegheny, Pa. App. filed Nov. 19, 1894. A lamp having a solenoid and an armature adapted to pulsate therein, a carbon controlling disc co-operating with a gripping device, both being connected by suitable toggle-levers.

546,691. CONTINUOUS-CURRENT RECTILINEAR MOTOR; C. E. Woods, Chicago, Ill. App. filed April 6, 1895. A motor having polar projections arranged along the path of travel, a number of magnetic cores mounted respectively upon a number of vehicles, each being wound with a number of coils, the ends forming a closed circuit, a commutator and brushes bearing thereon, whereby the current is directed through several series of coils through the agency of a single commutator, changing magnetic poles being produced in each of the cores adapted to react upon the fixed poles to propel the vehicle forward.

546,724. ELECTRIC SYSTEM; M. J. Wightmann, Johnstown, Pa. App. filed April 3, 1895. An electrical machine consisting of a single armature, a plu-

rality of fields, a source of current supply and independent connection from the source of current, and each of the fields and independent connection from the portion of the armature controlled by each field, and a translating device.

546,725. SELF-ACTING COMMUTATOR FOR TELEPHONES; S. B. D. Apostoloff and M. Freudenberg, Paris, France. App. filed March 27, 1895. The combination of a series of contacts, a movable switch point and electrical means for shifting the said point; circuit changers for breaking the line connection during the shifting of the point, and electrical means for re-establishing such connection when the point has reached the desired contact.

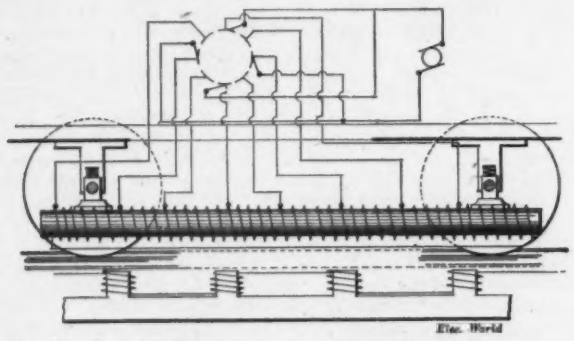
546,731. TELEPHONE SYSTEM; W. W. Dean, St. Louis, Mo. App. filed May 18, 1895. A system consisting of a central station having two parallel branches, suitable switching apparatus, an induction coil the secondary winding of which is included in the circuit, and a portion of the primary circuit in each of the two branches of the local transmitter circuit; a battery to actuate current and devices to prevent leakage of the current.

546,739. METHOD OF MAKING POROUS PLATES OR ELECTRODES; J. Johnson and J. H. Robinson, Brooklyn, N. Y. App. filed April 2, 1895. A method of making electrodes which consists in making a chemical mixture of a molten metal and an inert non-conducting porous substance and subjecting the said mixture to an electric current.

546,749. AMALGAMATOR; G. M. Urie, San Francisco, Cal. App. filed April 5, 1895. The combination of a revolving receiving screen having a vertical chute at one end, stationary screens of finer mesh to receive the screenings from the revolving screen, rotary conveyers, magnetic revolving cylinders located below the same, and an amalgamating pan provided with riffle plates, an oscillating electrode suspended above, and connectors connecting the pan and the electrode with the positive and negative poles of a generator.

546,756. PRODUCTION OF DISPLACED PHASES AND ROTARY FIELDS; C. S. Bradley, Avon, N. Y. App. filed Dec. 24, 1894. The combination of a compound and a simple coil suitably spaced on a ring or drum core, the compound coil being connected in two branch circuits containing an inductance and condenser adjusted to produce a definite displacement of phase.

546,799. ELECTRIC LIGHT DISPLAY SYSTEM; J. E. Woodbridge, Duluth, Minn. App. filed July 8, 1895. The combination of a display board having a number of electric lamps, each connected to a switch, and means for closing each or all of the circuits leading to the lamps, so that the circuit that is closed through any lamp is maintained by the magnet holding switch, and a hand switch in the main circuit to turn off the current and break the circuits or the switches.



No. 546,691.—Continuous-Current Motor.

546,802. SCREENING ELECTRICAL INSTRUMENTS AND APPARATUS; W. E. Ayrton and T. Mather, London, Eng. App. filed July 3, 1893. A screening consisting of a transparent cover formed of adhesive and conducting material.

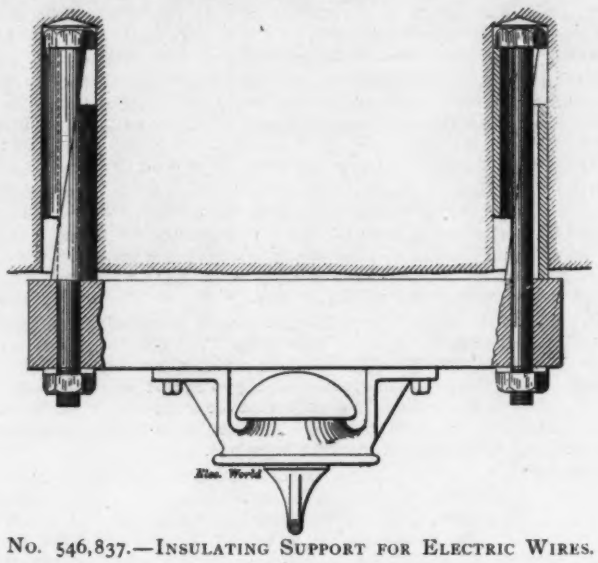
546,806. FREQUENCY CHANGER; E. J. Berg, Schenectady, N. Y. App. filed June 21, 1895. The combination of a generator having lines leading therefrom, an induction motor with its inducing member supplied from the lines and its induced member supplying other lines. drills or other tools connected to the lines supplied from the induced member, and an exciter supplying the generator and the continuous-current coils upon the drills.

546,820. Filed Jan. 4, 1895; 546,821, filed Jan. 4, 1895; ELECTRIC SWITCH; G. E. Linton, Worcester, Mass. The combination of a switch-knife having a plurality of split contact pieces, an independently adjustable bolt and nut for clamping the contact pieces into engagement with the said knife, means for holding it in its adjusted position, and also means for simultaneously actuating the clamping devices.

546,826, filed Nov. 16, 1894; 546,827, filed March 5, 1895; 546,828, filed March 5, 1865; ELECTRIC ARC LAMP; R. Schefbauer, Paterson, N. J. The combination of carbon holding arms, pivots for the same, gearing and a fly for regulating the approach of the carbons toward each other, a frame for the gearing and a lever connected therewith; a spring for actuating the lever in one direction; an electromagnet and its core for actuating upon the lever in the other direction, and flexible connections between the lever and the core for preventing vibrations in the core extending to the carbons.

546,837. INSULATING SUPPORT FOR ELECTRIC WIRES; J. N. Bulkley, Ridgway, Penn. App. filed March 4, 1895. The combination of a headed bolt and nut and wedging tubular sections diagonal from end to end and adapted to fit over said bolts and be arranged to overlap each other in wedging relation to each other.

546,874. ELECTRICAL INDICATING SYSTEM FOR ANNUNCIATORS; W. F. Banks, Milford, Conn. App. filed Oct. 2, 1895. The combination of a call box having a low resistance electromagnet, an annunciator having a high resistance electromagnet, an indicator having a low resistance electromagnet adapted to operate in connection with the call box electromagnet to indicate the special call sent and to give a return signal, and suitable means for automatically opening the circuit that a second circuit controlled by a switch may be established.



No. 546,837.—Insulating Support for Electric Wires.

546,892. TELEGRAPHIC VIBRATOR; P. La Cour, Askovshus, Denmark. App. filed May 7, 1895. The combination of a separately mounted movable circuit controlling body arranged to be actuated by the movement of the vibrator, a movable catch constructed to engage the said body, and means for operating the catch to release the body.

546,901. ATTACHMENT FOR ELECTRIC GENERATORS; G. W. Pickett, Denver, Col. App. filed Jan. 12, 1895. The combination of a dynamo, a commutator, an auxiliary commutator revolvable on the main commutator and provided with whole or half contact rings: an elliptical gear rigidly connected with the auxiliary commutator, a pinion to drive the same, and an operative driving connection between the said pinion and the armature shaft of the dynamo.

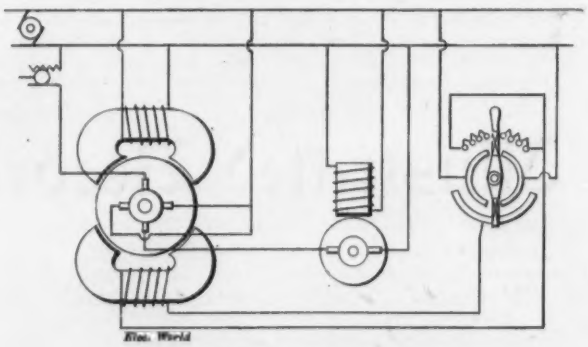
546,904. COMBINED DISTRICT TELEGRAPH AND TELEPHONE SYSTEM; E. E. Salisbury and A. E. Deane, Tacoma, Wash. App. filed Aug. 21, 1894. The combination of a signaling apparatus, a telephone circuit connected to contacts and also to the contacts of the signaling apparatus, and a movable telephone support connected to and adapted to actuate the signaling apparatus.

546,917. ELECTRIC MOTOR; J. A. Dejardin, Paris, France. App. filed April 20, 1895. The combination of fixed and movable coils, a pivoted balance beam, a chain with one end secured to the beam and the other to a drum, and means for continuously unwinding the chain from the drum throughout equal intervals of time and winding it on the drum at other intervals.

546,957. FUSE CONNECTOR; A. Gartner, Newark, N. J. App. filed July 25, 1895. A terminal having a plate provided with a central raised portion forming a spring, and an extension integral with and lapped under the said plate.

546,965. TELEPHONE; G. A. Tower, M. Hunter and J. F. Eastwood, Richmond, Va. App. filed Dec. 20, 1894. The combination of a support having an opening, a plate of carbon secured rigidly over the same forming the diaphragm; a rod supported in the rear, a series of pendent carbons supported thereby, and conductors, one of which is connected to the diaphragm and the other to the rod, supporting the pendent.

546,966. ELECTRICAL SYSTEM OF MOTOR REGULATION. M. J. Wightman, Johnstown, Pa. App. filed March 27, 1895. The combination of a source of constant potential and a translating device, a counter E. M. F. consisting of a dynamo having a single simple armature, one portion of which is in shunt to the source of potential and another portion to the source of potential and in series with the translating device.



No. 546,966.—Motor Regulation.

546,972. TELEPHONE ATTACHMENT; L. J. Gerson, Philadelphia, Pa. App. filed Jan. 14, 1895. A speaking attachment consisting of an attaching frame and a speaking tube connected therewith by a ball-and socket joint, whereby the tube may be turned in any direction.